Cloudburst 2

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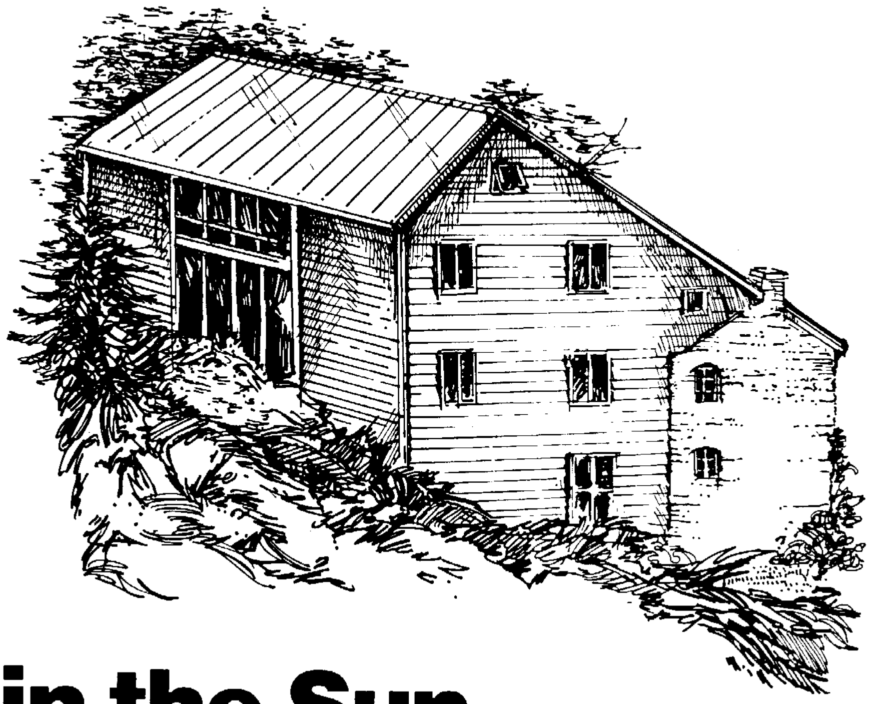
Preparing Cloudburst 2 has taken much longer than I ever expected when I mentioned in the first Cloudburst that a second column would be in print within a year – it's taken three. The compilation and editing was a slow, steady and exciting process. Letters have come from all over the globe expressing an interest in "appropriate" technology and I hope that Cloudburst 2 fulfills the expectations of those who wrote.

Throughout the book, certain words in the text are in **bold** type. This means that they are defined in the glossary on page 127. For those of us fumbling through the metric revolution, the conversion table on page 128 will be useful. Cloudburst - a handbook of rural skills and technology (volume one of this series) is still available from the publisher (Cloudburst Press, Mayne Island, B.C., Canada V0N 2J0). It's cost is the same as this volume. Plans are underway for Cloudburst 3, so if you have ideas or information to contribute, please send them along to the above address.

Vic Marks
February 1976



by Philip Brachi

Plumbing in the Sun

The theory is simple. Even our notorious British climate offers an average 1400 hours of sunshine annually, delivering some 900 kilowatt hours to each square metre of Wales and England. A black surface will absorb most of the energy and turn it into heat; so trap this beneath a layer of glass or plastic, opaque at those longer wavelengths, and carry the heat away somewhere useful.

Unobscured and unobtrusive, a roof is the obvious place to erect such a sliver of a greenhouse; sensible too, because the same structure keeps the house dry. Programs exist to compute optimal orientation (a wee bit west of south?) and slope for solar roof siting. Orientation, though, will often be dictated – as here at Eithin-y-Gaer – by an existing building; and the programs have demonstrated their own redundancy, by proving that pitch is far less critical than area. So build big if you can; ours is 60 square metres.

Set on a north-facing hillside, with some shading from apple, ash, and elm, our home-built home is a compromise; having a southern horizon above which the Sun never rises for six mid-winter weeks, and an orientation 30° west of south, meant that our roof could never be optimal. But then reality rarely is. We chose a 30° pitch, angled for the six months of high summer Sun, which contains almost 80 per cent of the year's energy harvest in these climes. We are living at about latitude 52½° north – approximately on a line with the Northern tip of Newfoundland, Saskatoon or the Queen Charlotte Islands. Elsewhere, follow the plans.

Our solar system is indirect; as the plumbing diagram (Fig. 1) shows, the hot water drawn at the tap is not the water which passed over the roof. This choice was made for several reasons. The circulating pump is happier without new water all the time to corrode its impellor; and there is less furring-up by salts depositing on the hot aluminium. Additives, too, can be experimented with. Inks to darken the water and aid heat absorption, perhaps; copper sulphate to prevent algae growth, should that prove problematic; and we've found that a little detergent (Sunlight, of course!) lowers surface tension, helping the water to spread out as it runs down the roof.

An eminiently do-it-yourself proposition, the intermittent man and woman-hours between basket-making and baking amounted to perhaps 6 or 7 people-weeks.

Mid-July experiments have shown a steady state, in which water was running up to the roof at 62½°F (17°C) and returning at 113½°F (45°C), at the rate of one goat bucket-ful (4.9 litres) every 27 seconds. That is 21.5 kilowatts, or about seven domestic immersion heaters. The 60 square-

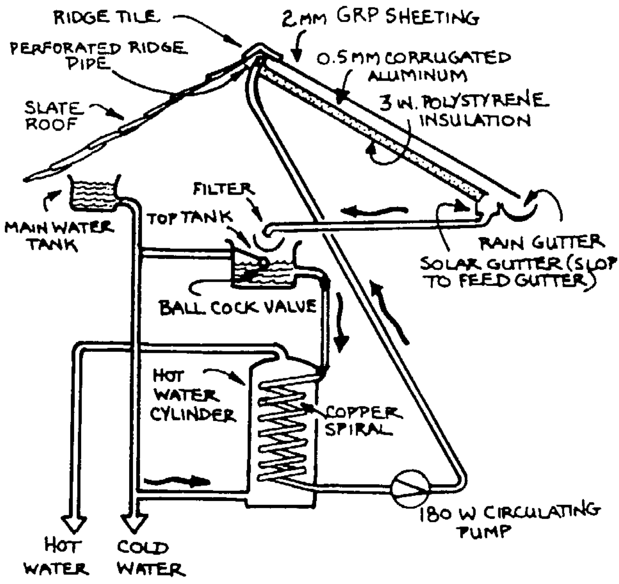


FIGURE 1

metre roof was extracting 40-45 per cent of the Sun's energy offering, which, an hour past its highest, we guessed to be 800 - 900 watts per square metre.

Stefan's Law suggests that the 50°C kitchen tap record-to-date will not easily be bettered, as efficiency falls off sharply above these temperatures. But this also means that the roof performs best when needed most – when starting with a cold tank.

And how does the system know when to start?

Sensitive controls of the solar system is very important, as a glance at the water circuit will confirm. If, after warming up the hot-water cylinder, the Sun clouds over, then the system left running will be heating the mid-Wales sky for those lucky buzzards! The roof must be switched off. If, however, a couple of baths are then taken, cold water replacing the hot water drawn will so cool the cylinder as to make it worthwhile turning on the pump once more.

What is required, then, is a continual comparison of roof temperature with that of the hot water cylinder. The black box to do the trick has proved invaluable. Awake day and night, it occasionally has the roof using diffuse sunlight before 7 a.m. solar time.

As yet, there have been few problems. Filtration, though, must be careful and continuous, or live beetles, elm seeds, and other aliens somehow intrude. Running a bottle-brush through the ridge pipe is a drag! Condensation on the under surface of the GRP sheets affects the upper (hotter) half or third of the roof, and must be reducing efficiency; it causes some water transfer to the rain gutter, too. To counter this, we are going to increase the flow-rate, lowering the steady state temperatures. Or should we do a little lateral thinking, and use this effect to distill our elderflower wine?

There was, of course, that imperial snarl-up when I forgot the aluminium roof was the only item in the house not built to an 18-inch module. Three feet into 900 millimetres won't go! Embarrassed consultations of "GRP Technology" advised diamond-tipped circular saws at 10,000 s.f.m. Being caught short on these, we used garden shears.

Some improvements to eke further ergs come to mind. A 300-gallon tank replacing the 39-gallon one will make much fuller use of the roof's power; the hot water will be at a lower temperature, so we'll add less cold when bathing. Fine-tuning of the black box, along with improved thermal contact for the thermistors, should make the control even more responsive. The attic still gets amazingly hot, though, so perhaps we should go up from 3 to 6 inches of insulation below the roof.

The place of Alternative Technologies

Alternative technologies could well be evolved on a lab bench in the city; but to do so would miss the point. Like the good Peter Harper says, "AT is not really about new pieces of hardware, but about our whole approach to living, production, consumption, and fulfilling our goals."

Decentralisation is of the essence. How does the Sun's energy arrive, after all? The effort to promote hectare-gobbling solar stations for the electricity grid is technocratic tunnel-vision. Or has it something to do with the way in which power, in that other sense, is distributed within our parlous state. Ambient energy from sun, wind, and water is hard for anyone but the user to control, and correspondingly unlikely to be misused.

Against the advocate of solar roofs are ranged various objections: "How do you heat water in winter?" and "How much energy went into making all that aluminium and plastic?" The answers are: a heat pump, to give 12 kilowatt-hours of heat out for 3-4 kilowatt-hours of electricity in; and about 15,000 kilowatt-hours, which we should be able to collect as hot water in year or two. More serious is the criticism that such AT gadgets affect only the technology of consumption, ignoring the organisation of production and its attendant horrors. In a word, it's bourgeois. What about inequality, alienation, exploitation? How does Amalgamated Greed treat its black workers in the bauxite mine behind the aluminium roof?

Maybe we now have a more realistic view of what AT can achieve. Alone, it is not going to change the world, or anything very much, but will be lovingly co-opted by big business. Yet AT is not alone, but a part of something far larger, less obvious. The manifestations are everywhere: free schools and housing associations, food and craft co-ops, white bicycles, squats and work-ins; even at the production end, things are changing slowly. Together amounting to a movement, rough but real, such developments can only multiply the potential of this cheerful roof.

Being a community, we do not see this as a purely technical achievement, nor an economic one to save us $250.00 a year. There is, though, the rare sensuality of bathing in rainwater warmed by the sun. And as part of the home that we and our friends built for ourselves, it perhaps has a certain spiritual dimension, contributing a little to that softest, least palpable technology of them all; a group of people slowly coming together communally under one roof.

Completed in June 1974, our solar roof supplied hot water for about ten people through a poor summer till early October. These plans should enable handymen and women to build their own, giving 6-8 months hot water yearly, for about 3 cents a day, and lowering winter fuel bills too.

How It Works

A dark surface – in this case a corrugated **aluminum roof** –will absorb most solar energy and turn it into heat; a layer of glass or plastic **glazing**, secured on **glazing bars**, prevents this heat escaping skywards. The corrugations run down the aluminum roof's slope, each "valley" being fed a trickle of water from a perforated **ridge-pipe** running along the roof's ridge. The water, warmed in its passage down the aluminum, collects in a plastic **gutter** and gravity feeds indoors. Flowing through a copper spiral within the hot water cylinder of the domestic **plumbing** system, it yields up its heat, and is then recycled by a small pump back up to the ridge. A top-up tank in the system allows filtration, and any occasional water losses are made good there. South is the best orientation, but wide variation seems possible; our roof faces 30°W of south. A 30-35° slope is optimal for the six months of the summer sun which comprise nearly 80% of Britain's solar energy input. Elsewhere, make the slope latitude minus 20° roughly, for summer use. * **More important is to build big**, ours, 60 square metres (60m^2), has given 21.5 kilowats on a sunny July lunchtime.

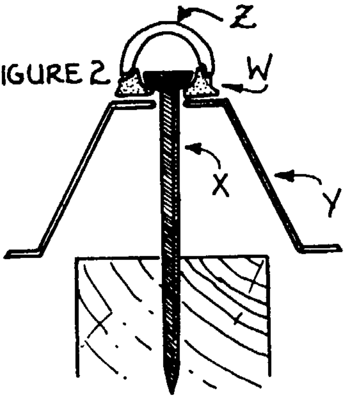
Construction

These plans assume working with exposed rafters, but the techniques could be used to build smaller panels, skylight fashion, or to make free-standing solar collectors for backyard experiments.

The Aluminum Roof

This was made from Granges Essem TRP 40 corrugated sheet, 0.5 mm gauge, factory coloured dark grey. Allowing for overlap, each sheet covers 900 mm width, supplied cut to length required. Fixing the lightweight aluminum roof to the rafters **must** be done with aluminum nails, **not** steel, to avoid electrolytic corrosion between these metals. Plastic washers (W in fig. 2) cushion the heads of the 4" (100 mm) nails (X) tight against the roof (Y); a plastic snap-fit dome (Z) attached to the washer seals the fixing. Nail the aluminum sheets through their ridges, because the valleys will later run with hot water. If the attic rafters do not coincide with the ridges of the aluminum sheets (the TRP 40 sheets have ridges every 100 mm), nail noggins 4" x 2" (100 mm x 50 mm) wood between the rafters, and fix the aluminum to them. Remember to leave the complete length of every ninth ridge of the aluminum roof free of fastenings, so that glazing bars can be attached later. The house now has a strong aluminum roof, quite capable of carrying two people, provided weight is spread by working from a ladder secured over the ridge of the house.

FIGURE 2



The Gutters

The **solar gutter** collects water from the aluminum; it slopes about one inch in 15 feet (0.5 per cent) toward a convenient point to enter the house and join the plumbing system. Using ordinary 3" (70 mm) plastic guttering, seal the joints between sections with "Plastic Padding": hot water leaks easily! Secure the gutter to the ends of the rafters. Insulation beneath and beside the solar gutter is well worthwhile. A downspout connector (A in fig. 3) and a 45° angle piece (B) are fitted to the gutter where the solar water is fed indoors. Roughen their joining surfaces and glue with "Plastic Padding" (C); again use it (D) to connect the 45° angle piece to the polythene plumbing (E) emerging from the wall of the house (F). The **rain gutter**, attached to the house **fascia**, collects rain from the glazing. (N.B. Until all glazing is in place, the solar gutter acts as rain gutter; think, and plumb, carefully, or you may divert a cloudburst indoors! Don't connect the plumbing to the solar gutter until the glazing is completed.)

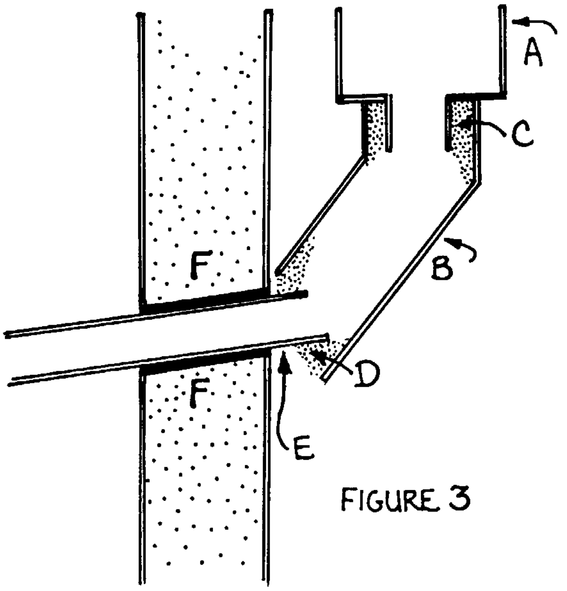
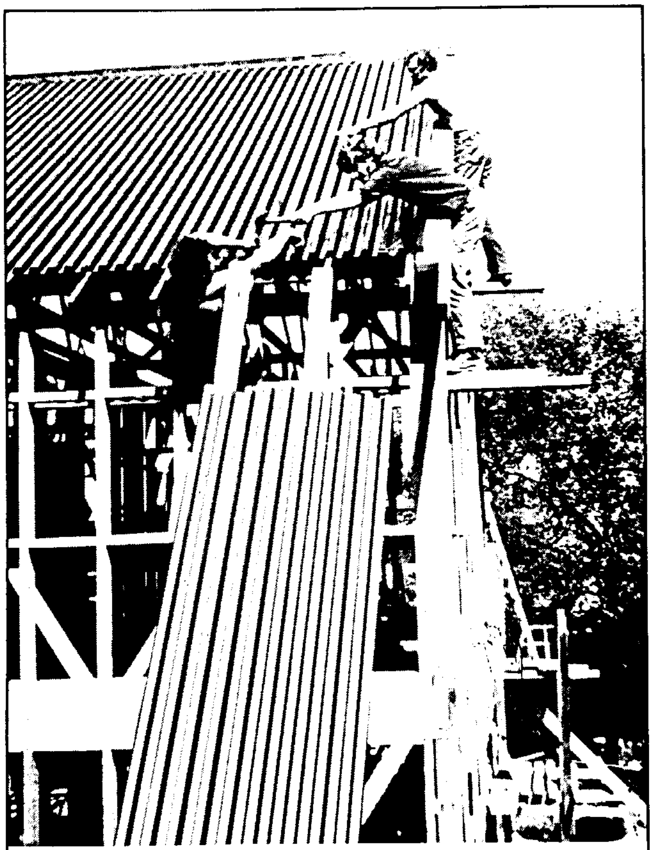


FIGURE 3



PUTTING ON THE ROOF

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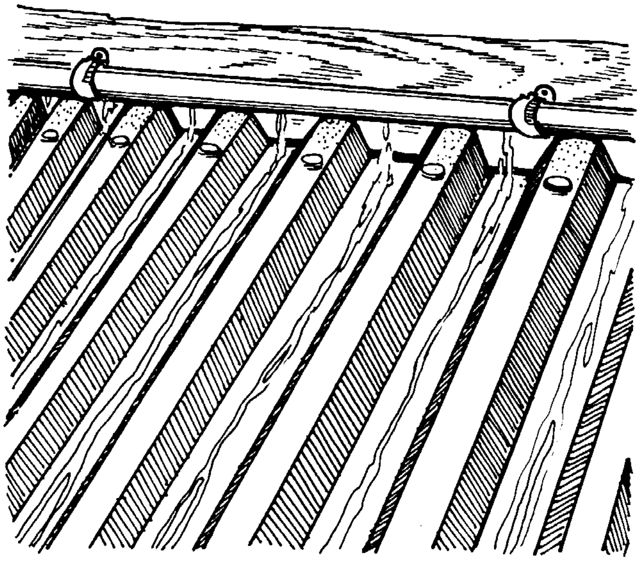
*Much steeper is best for facing the lower winter sun, but this is architecturally harder, reduces the roof's summer performance and, of course, much less solar energy is available in winter.

The Ridge Pipe

Ours is ¾" (18 mm) internal diameter copper tubing; because of increased costs, plus the possible electrolytic problem of copper near the aluminum roof, we now favour rigid PVC tubing. Holes 5/64" diameter (2 mm) are drilled every 100 mm to coincide with each valley of the corrugated roof. With a bottle-brush, clear out any swarf after drilling, as this may clog the small holes when the ridge-pipe is operating. Leave the installed ridge-pipe's ends sealed with a threaded openable plug: if filtration ever fails, the pipe can be flushed out, or the brush drawn through with a stiff wire. The ridge-pipe is secured to the wooden ridge-plate structure of the house, positioned so that its holes drop water directly into the valleys of the corrugated aluminum. Water reaches the ridge-pipe via two connections, spaced a quarter of the way from each end; this makes the water flow from the pipe more evenly than if the supply is pumped only to the centre or end of the roof.

FIGURE 4



THE RIDGE PIPE

The Glazing Bars

These run from top to bottom of the roof along every ninth ridge of the aluminum, forming frames 900 mm wide to hold the glazing sheets. The recess in the bottom of the glazing bar fits the square head of an aluminum bolt 7/8" (20 mm) long; (the bolts and nuts, plus self-tapping screws, capping strip, and PVC seals are all supplied with the Frampton Furguson C70 glazing bar). Their bolt makes a simple fixing direct to the aluminum roof, but on our windy hill we chose the more secure fix shown. Brackets (12 in fig. 5) made from one inch angle iron are fixed to the attic's rafters directly beneath each ninth ridge of the aluminum roof. Bitumin damp-proofing material (DPM) cut into strips (8) helps the glazing bar to seat tightly and offers some heat insulation, preventing the glazing bars from cooling the roof. Electrolytic corrosion between the steel nut (6) and aluminum glazing bar is avoided by a home-made polythene

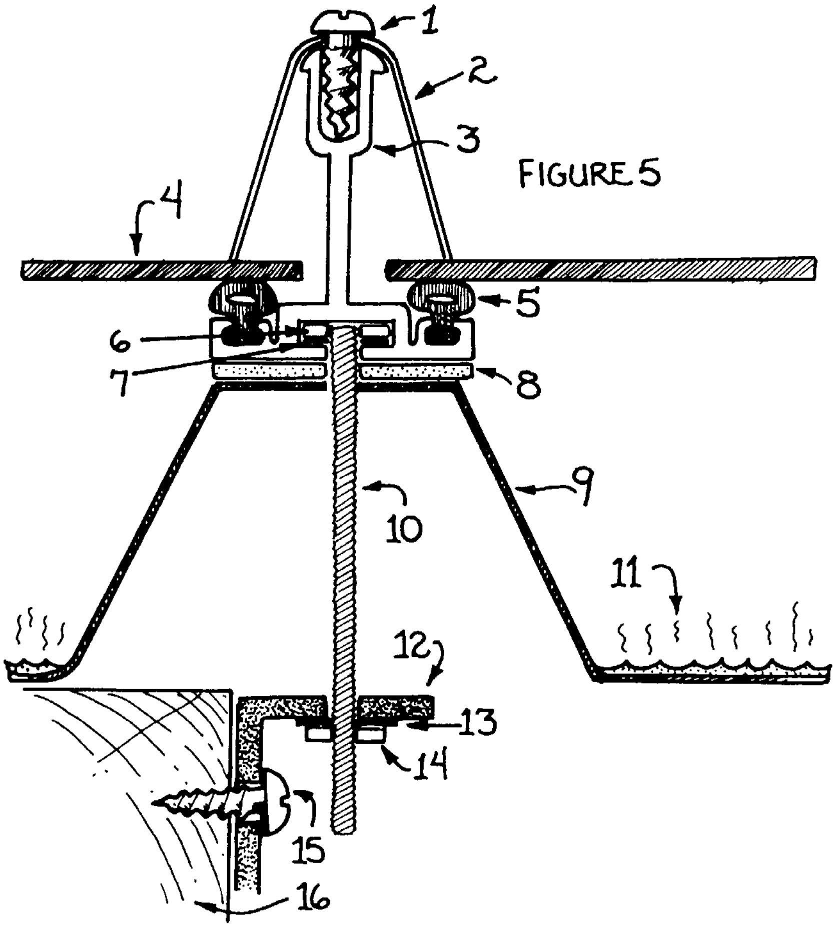
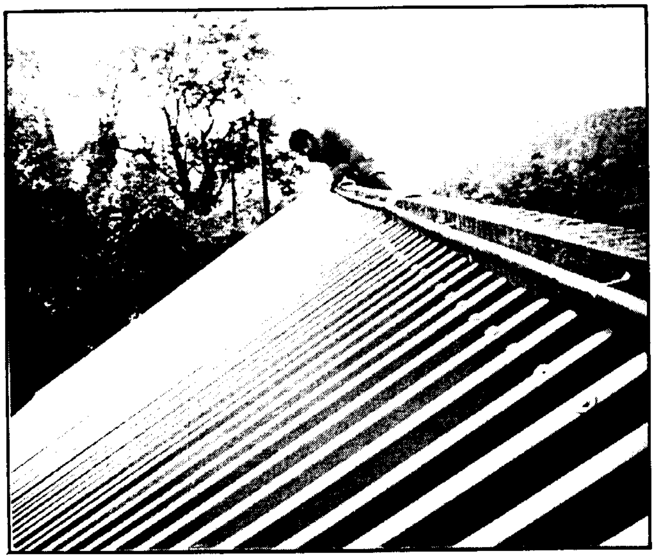


FIGURE 5

1 SELF-TAP SCREW
2. CAPPING STRIP
3. GLAZING BAR
4. GRP SHEET
5. PVC SEAL
6. NUT
7. POLYTHENE WASHER
8. DPM STRIP
9. ALUMINUM ROOF
10. THREADED BAR
11. HOT WATER FLOW
12. ANGLE BRACKET
13. WASHER
14. NUT
15. WOOD SCREW
16. RAFTER



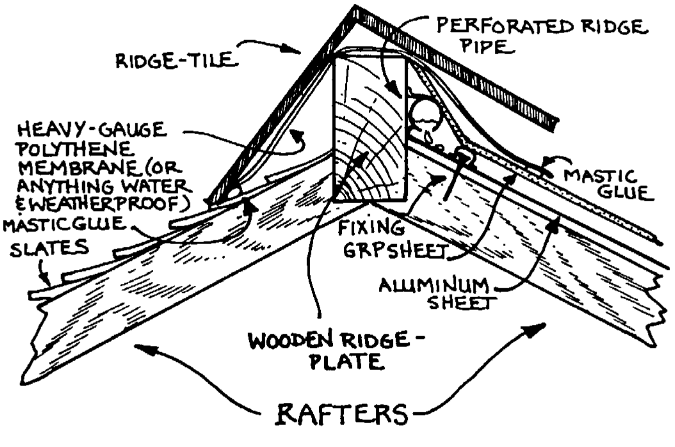


FIGURE 6

washer (7); the threaded bar (10) is protected by gloss paint where it passes through the aluminum roof. The entire fixing occurs every 59" (1.5 m) for each glazing bar.

Glazing the Roof

Using plastic may seem nonsense: glass is half the price and more transparent; besides, to glaze with plastic is hardly good English! But, from experience, glass is problematic: weight, fragility, sharp edges, and impossibility of placing weight on glass once laid in place – all combine to favour glass-reinforced plastic (GRP) sheeting; e.g., Mitra's Mitlite, 2 mm thick. GRP is light, safe, flexible and extremely tough; made to size, each sheet runs from ridge to gutter; ours were over 16 ft. (5 m) long; a glass version would require several separate sheets, with algae and dirt problems where they overlap. However, GRP does sag between the glazing bars, reducing efficiency by touching the aluminum roof; extra plastic domes (Z in fig. 2) are nailed to the ridges of a few corrugations to lift the GRP. Longer than the aluminum, since they run beyond the solar gutter to the rain gutter, the GRP sheets are easily lifted and laid in place between two glazing bars. (With glazing bars spaced at 900 mm intervals, 885 mm is a good width to order the GRP sheets.) At its top end, the GRP can be flexed to ride up over the ridge-pipe and fit tightly against the wooden structure of the house (fig. 6). The sheet is secured, starting from the lower end, by screwing the capping strip (2 in fig. 5) onto one supporting glazing bar. The second glazing bar is left uncapped, ready to receive the next GRP sheet. Gaps at the top and bottom of each sheet, where air might circulate, should be sealed with plastic foam cushion, visible in fig. 7.

Plumbing

All pipes carrying solar circulating water are "Class C" polythene, using the Tubelock connection system. Plumbing from the pump to the ridge-pipe is ¾" (18 mm) internal diameter, the remainder 1" (25 mm). The 39 gal. (177 litre) hot water cylinder, with its copper spiral, is commonplace; most centrally-heated homes have one. For winter, an immersion heater can be fitted. The SMC Commander S circulating pump lifts 2.4 gal./min. (11 litres/min.) through a maximum 14 ft. (4.3 m) head; beyond this, a larger pump is needed. Flow rates can be experimented with by varying pump speed or size; for the 650 ft.^{2} (60 m^2) roof, our rate may be a bit low. Keep the slope of the gravity feed from the solar gutter to the top-up tank constant, without sagging, to prevent airlocks when the system is switched off.

Operation

Using its sensors (fig. 8: TH1 on the hot water cylinder, TH2 on the back of the aluminum roof), the **Black Box** controls the pump, on and off, only running it when the roof is warmer than the cylinder by a few degrees, adjustable by VR1. Filtration must be continuous, or else insects, etc., enter the system, blocking the ridge-pipe's holes; hence the kitchen sieve above the top-up tank, emptied monthly; and now a tea-strainer across its exit, too. A little detergent in the tank promotes inner cleanliness, helping the water to spread out as it runs down the roof. Temperatures have reached 126°F (52°C), way too hot to touch, at the kitchen tap; but heat losses are less and efficiency greater if a larger

GLAZING THE ROOF

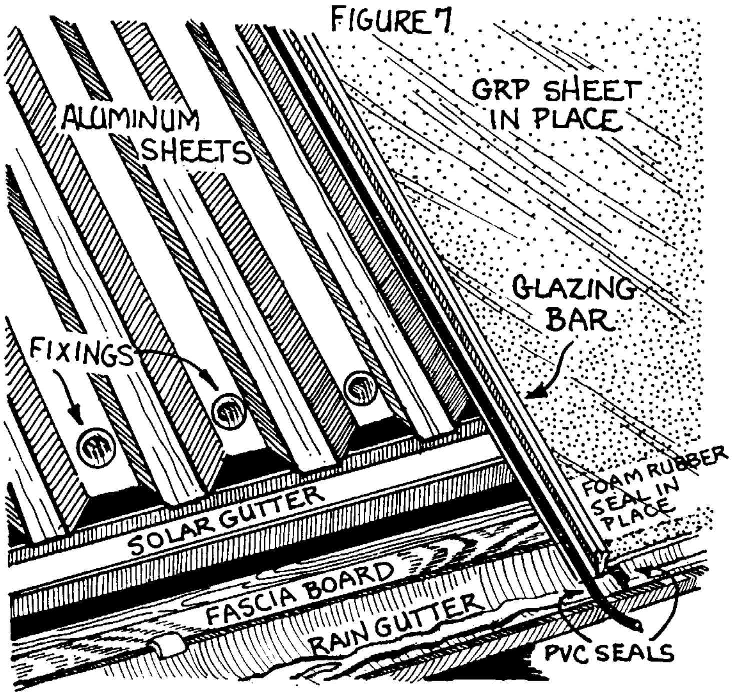


FIGURE 7

volume of water is stored at somewhat lower temperatures. Insulation is vital. We have 3" (75 mm) polystyrene block behind the aluminum roof, costing about $1.25 per square metre; the hot water cylinder, top-up tank, and return pipe are each boxed in with at least 3" of polystyrene. Frost damage cannot occur, since the roof drains whenever the pump switches off – a major advantage of this system. Condensation on the under surface of the GRP sheets affects the upper third or half of the roof, and must be reducing efficiency; yet we still get more hot water on a sunny day than we can use. Perhaps an increased flow rate might help, by lowering the roof's operating temperature.

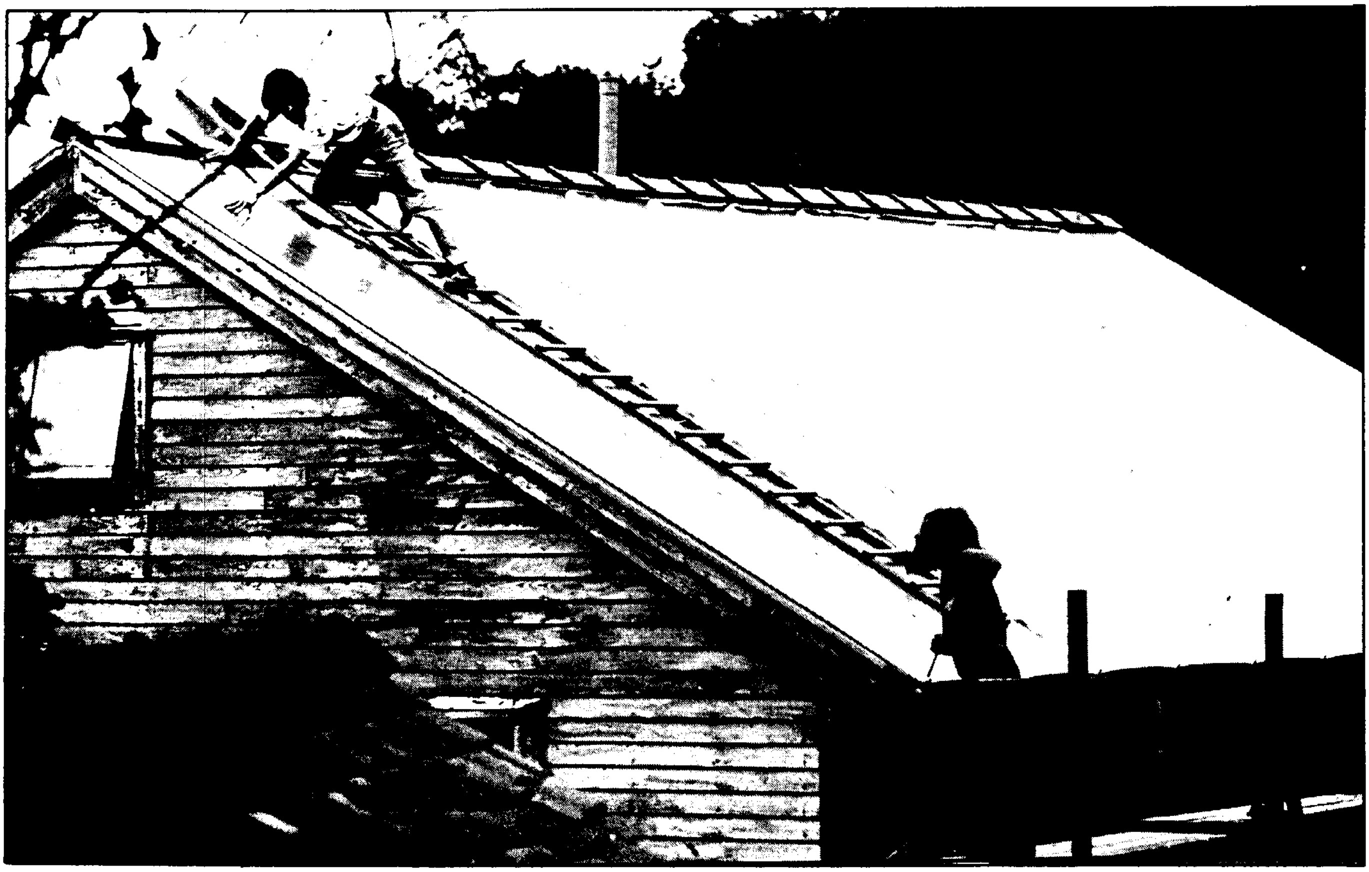
Bibliography

"Undercurrents" – "The magazine of radical science and peoples' technology." Bi-monthly (well, almost!) from 11, Shadwell, Uley, Dursey, Gloucester, England, $6.50 U.S. per year or equivalent – $8.00 U.S. for airmail. Plenty of items on do it yourself Solar Energy.

"Alternative Sources of Energy" -- $6.00 (U.S. currency only), from ASE Subscriptions, Route 2, Box 90A, Milaca, MN 56353, USA. Highly practical information on development of technologies for a decentralised society. No. 15 is a classified access list of over 1000 articles, books, addresses – $1.50. No. 17 – "Spectrum" is an equipment directory of alternative technologies – $2.50.

BRAD's solar roof: what it cost (1973-4)

Component:	Cost (£)	Cost/sq.m (£)
Corrugated aluminum	132	2.20
Glazing bars + fittings	50	0.83
Plastic sheeting (GRP)	246	4.10
Copper ridge-pipe	18	
Top-Up tank	4	
Extra plumbing	10	
Black Box control system	5	
Solar gutter	8	
Pump	17	
Fastenings, etc.	4	
Total cost in English Pounds	494	8.23
Total cost in Canadian Dollars	($1185.60)	($19.75)



The Black Box – Components

VR1	Potentiometer/4K7 Lin/P20
R1	Resistor/1K 1/3 watt/UPMO33
R2	Resistor/1K 1/3 watt/UPMO33
R3	Resistor/1K 1/3 watt/UPMO33
R4	Resistor/1K 1/3 watt/UPMO33
R5	Resistor/3K3 1/3 watt/UPMO33
R6	Resistor/100K 1/3 watt/UPMO33
R7	Resistor/78K 1/3 watt/UPMO33
R8	Resistor/33K 1/3 watt/UPMO33
R9	Resistor/4K7 1/3 watt/UPMO33
R10	Resistor/250 ohms 1/3 watt/UPMO33
C1	Capacitor/0.1μF400v/Siemans
C2	Capacitor/4700μF 25v/Siemans, axial lead
TH1	Thermistor/VA 1055
TH2	Thermistor/VA 1055
1C1	Integrated Circuit/LIC741C8, etc. (any 8-pin 741 type)
D1	Diode/silicon/IN916
D2	Rectifier Diode/S2CN1
D3	Rectifier Diode/S2CN1
S1	Main Switch/SPDT type/centre off 1019C
RS1	Reed Switch/250v 1 amp/SR1
I1	Reed Coil/12v > 800 Ω/SS/12
Z1	Zener Diode/10v 400mW
Z2	Zener Diode/3.3 400mW (optional)
T1	Mains Transformer/9-0-9 volts 100mA (e.g. Norman type CT1)
N1	Mains Neon Indicator/NR/R
O1	Mains Output Socket & Plug/P438
TR1	Transistor (PNP, Si)/2N3703

Also required: Integrated Circuit Holder (8-pin) EF 722-2-8; Veroboard 0.1 inch matrix, copper-clad, 3¾" x 5"; Aluminum Box 6" x 4" x 2"; Terminal Block 2 amp 12-way; Mains Wire (3-core); Knob for VR1 JV18; Mains Input Socket and Plug P340; 16 6BA Nuts & Bolts 0.375 inch, roundhead; Twin Coaxial Wire lightweight (links box-to-roof and box-to-tank); Mains Plug 3-pin fused; Fuse 1 amp for mains plug. Total cost for the black box is under $25.00 after VAT & postage, from Electro Value; or $12.00 shopping around, NB. THIS CIRCUIT IS NOT FOR BEGINNERS! Inquiries about the black box should be sent to John Wood, 899 Kingsway, Manchester 20, England; enclose an international postal reply coupon please.

Addresses of Suppliers

Granges Essem, Leon House, 233 High Street, Croydon, Surrey, England. **Frampton Furguson**, Barton Road, Comberton, Cambridge, England. **Mitra Plastics**, Whittington Road, Oswestry, Shropshire, England, **Bricell Plastics** (polystyrene), Worsley Road North, Walkden, Worsley, Manchester 28, England, **Electro Value**, 28 St. Jude's Road, Englefield Green, Egham, Surrey, England (Their catalogue codes are given in the Black Box components list.)

Questions about the roof may be addressed to Biotechnic Research and Development (BRAD), Eithin-y-Gaer, near Montgomery, Wales. International postal reply coupons must be included in all correspondence to BRAD or John Wood.

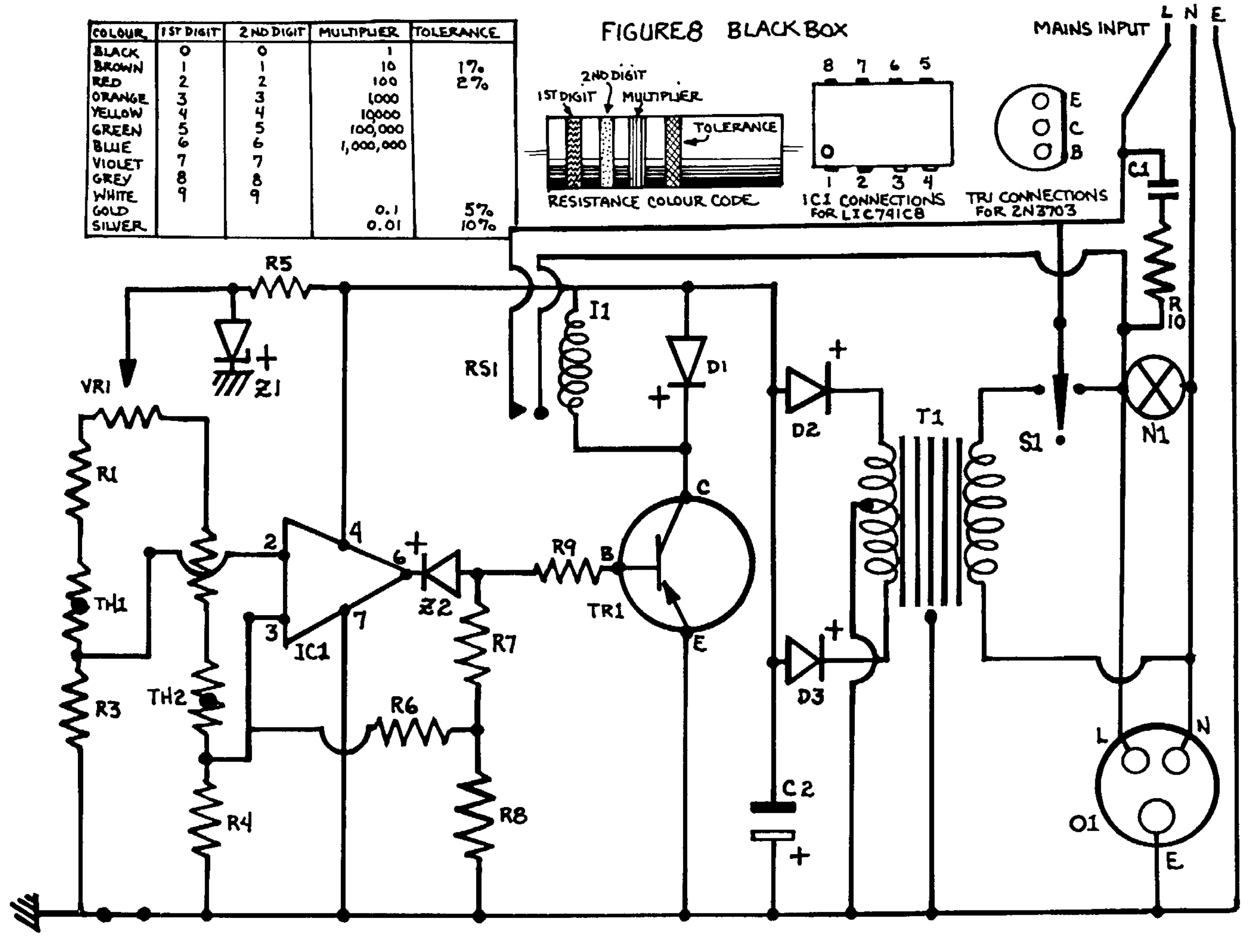


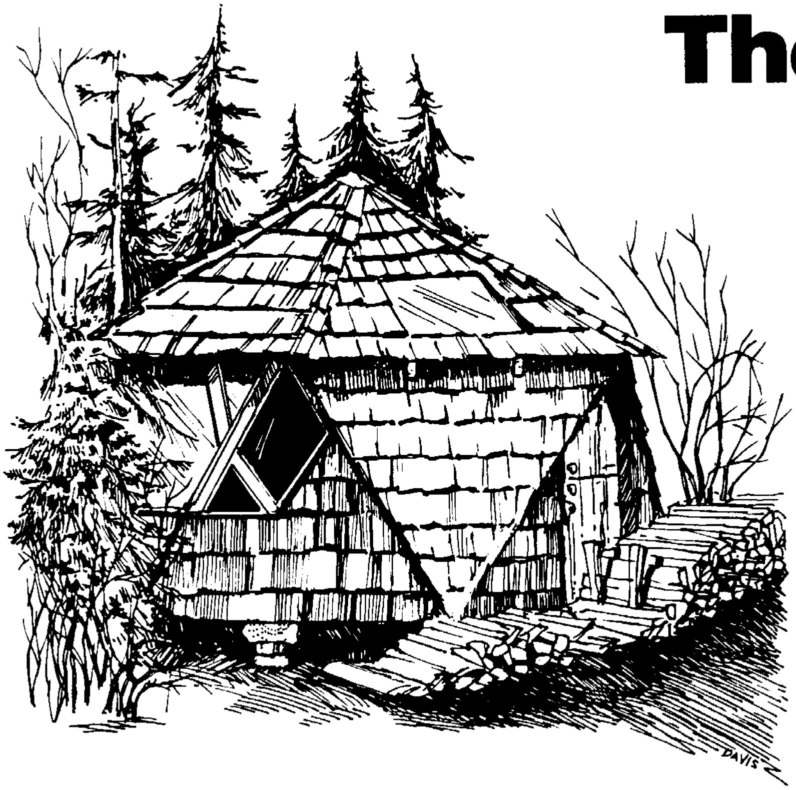
FIGURE8 BLACK BOX

COLOUR	1ST DIGIT	2ND DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	0	1	
BROWN	1	1	10	1%
RED	2	2	100	2%
ORANGE	3	3	1,000	
YELLOW	4	4	10,000	
GREEN	5	5	100,000	
BLUE	6	6	1,000,000	
VIOLET	7	7		
GREY	8	8		
WHITE	9	9		
GOLD			0.1	5%
SILVER			0.01	10%

The Eco*-Cabin

by Lance Bohlen

designed by Jim Bohlen



© 1975 by Greenpeace Experimental Farm

The eco-cabin is a unique structure, the shape being derived from a geometric solid called an icosahedron. The crystalline form is made up of 20 equilateral triangles. If a group of 5 interconnected triangles are removed, the shape of the cabin results. To aid in visualizing the structure, construct the model from Fig. 1. As is evident, the base or floor is a pentagon – 5 sided. It is interesting and convenient that any one side of the base is equal in length to any side of the remaining 15 triangles. In the actual cabin, the roof triangles are extended past the sides to form protective eaves.

This shape was chosen for a dwelling because of its simplicity of design, economy, ease of construction, great structural strength and maximum utilization of a minimal amount of materials. It has an advantage over "pure" domes in that placement of windows, doors and skylights is more conventional. Owing to its simplicity, most of the major components (foundation, floor and struts) may be pre-fabricated. This dramatically cuts down on construction time at the site. Another "plus" is that absolutely no power tools are required for construction, suiting remote locations. It is estimated that a well insulated eco-cabin will cost well under $1,000, even in inflationary 1975, complete with air-tight wood heater.

Tools

As mentioned before, only hand tools are necessary for construction. The required tools are:

brace and bit drill with a 3/8" bit
a quality crosscut saw, approx. 8 pts. per inch
4 foot level
hammer
shovel
axe
chalk line
adjustable wrench
screwdriver
12' tape measure
staple gun
carpenter's square
protractor square (available at most hardware stores)
bevel square
cheap hard-point saw (for ripping and cutting plywood)
bow saw (optional)

Materials

The most important factor in keeping the cost of your cabin low will be your ability to scrounge materials at the lowest possible cost. Although it is desirable to use re-cycled materials such as those obtained from wrecked buildings etc., many of us lack the facilities or capabilities to do it. An alternative is to scrounge in local lumberyards. Most lumberyards have a section reserved for utility grade lumber. It is usually in bundles of random lengths, although of the same stock size (2" by 4", 1" by 8", etc.). If you can obtain permission to pick through the bundles, you will find enough wood of suitable quality to fit your needs. Remember to keep the bundle orderly, so you can keep a good thing going! Here are some pointers to look for when sifting through the pile. Sight along the edge, and look for warp and straightness of grain. If the grain is very wavy, reject it. The same goes for a bad warp, unless it's near the end where you can cut it off and still have a good-size piece of wood left. Then check the knots. If

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* minimum ECO-logical and ECO-nomic Impact.

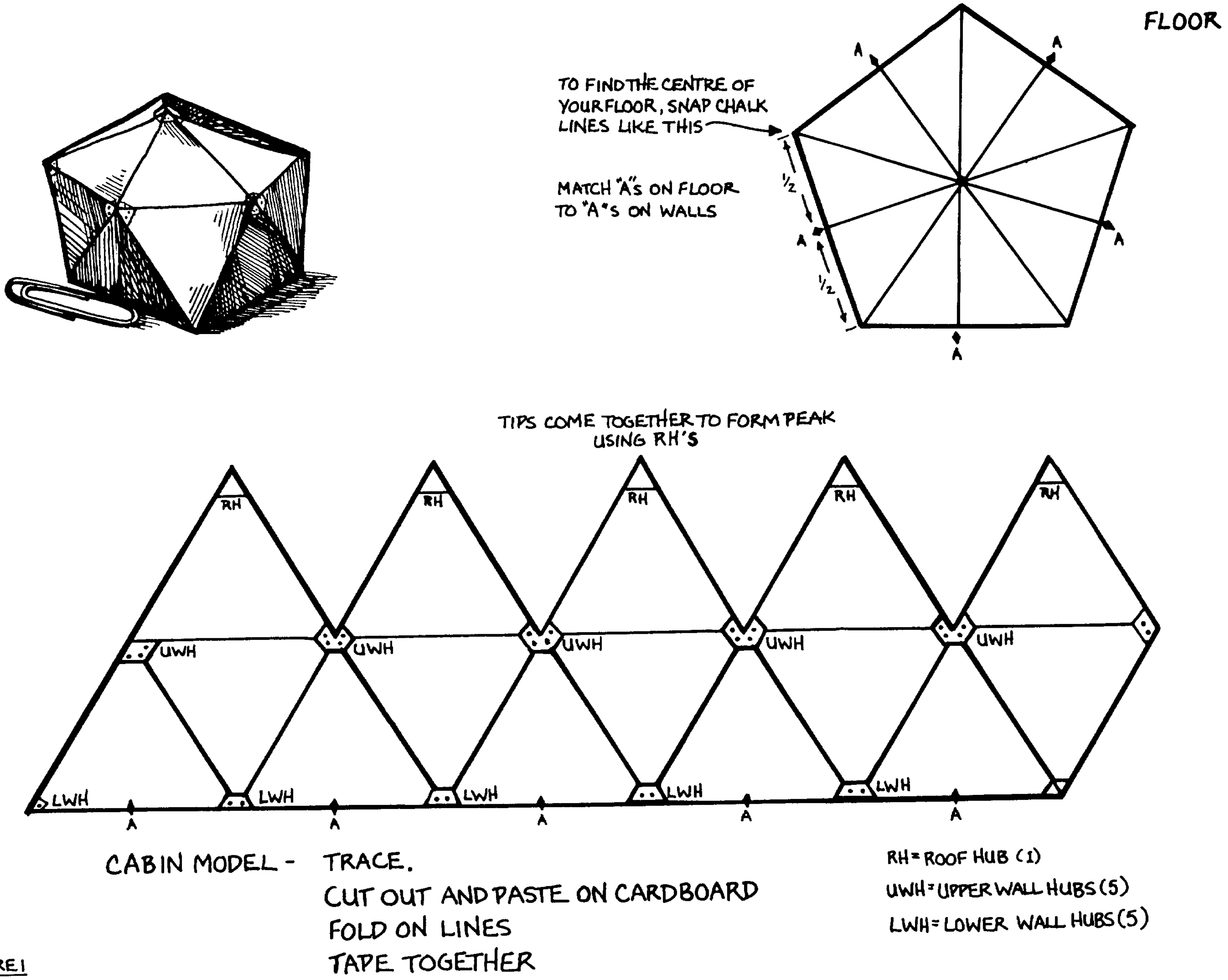

FLOOR
TO FIND THE CENTRE OF YOUR FLOOR, SNAP CHALK LINES LIKE THIS
MATCH "A"S ON FLOOR TO "A"S ON WALLS
½
½
A
A
A
A
A
TIPS COME TOGETHER TO FORM PEAK USING RH'S
RH
RH
RH
RH
RH
UWH
UWH
UWH
UWH
UWH
LWH
LWH
LWH
LWH
LWH
A
A
A
A
A
CABIN MODEL - TRACE.
CUT OUT AND PASTE ON CARDBOARD
FOLD ON LINES
TAPE TOGETHER
RH = ROOF HUB (1)
UWH = UPPER WALL HUBS (5)
LWH = LOWER WALL HUBS (5)

FIGURE 1

they are more than ¼ the thickness of the wood in depth, reject it, unless it's near the end. This criteria does not apply to sheathing material. Look especially for decay. If it can be cut out, okay; if not reject. Some lumber may be badly checked (split) on the ends. This is alright, if it does not extend too far up the board. Planer skips are okay, unless they visibly weaken the board.

Materials List

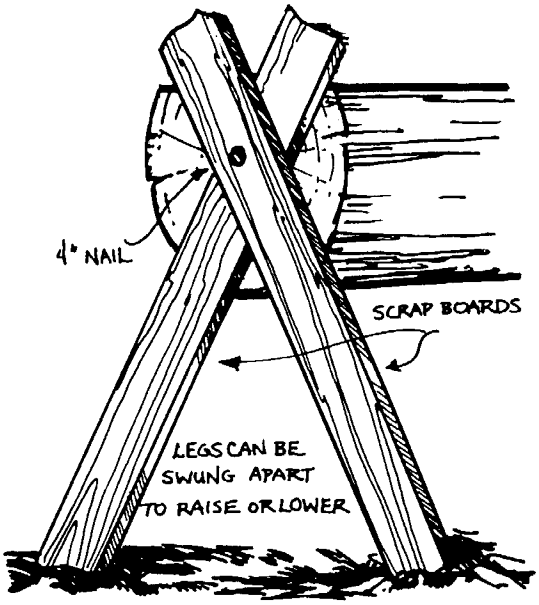
35 – 5" long, 3/8" diameter carrage bolts, nuts and washers
5 – 4' by 8' sheets of tongue and grooved ¾" plywood
15 – 8' long 2 by 4's construction grade (for wall struts)
250' lineal feet of 2 by 4's for roof, door, etc. (utility) 12' - 16' lengths
14 - 10' long 2 by 6's for foundation
1000 board feet of utility grade 1 by 8 shiplap (for sheathing)
1 roll of roofing felt
2 boxes (1000 each) 5/8" staples and gun
1 qt. roofing cement
2" and 4" common nails
chimney jack, vent, door hardware, rope, etc.
urethane or styrofoam insulation for roof
fibreglass insulation for sides and floor
windows
materials for outer skin

Construction of Foundation

Before you begin actual construction, decide exactly where you want the door and windows to go. If you want a large window oriented south, decide whether you want it slanting in or out. Use your model and sketch in the windows, door, and skylight. Then mark the orientation at the construction site.

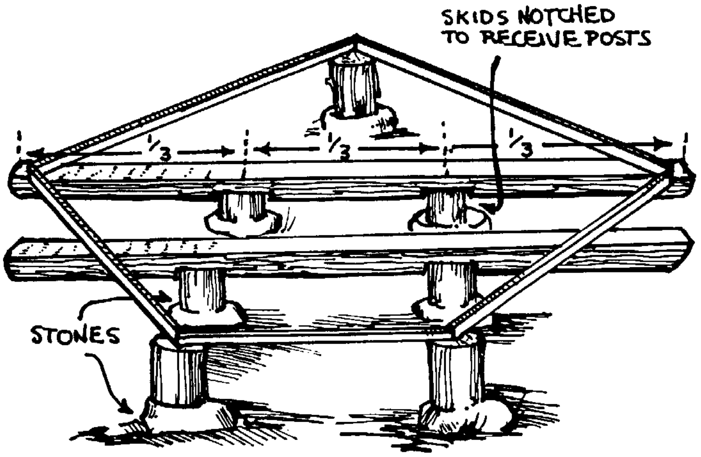
The first step is to prepare the skids. The skids are two logs of equal length, on which the foundation is attached. Locate two logs approximately 15' long and over 6" in diameter. They should be peeled so no destructive insects are harboured. Next, adz or flatten one side to provide a level surface. To do this, sight along the log to find the straightest edge. Then snap two parallel chalk lines 4" apart. Use an axe to chip away the wood between the lines, sighting along the log as you go. When this is done, lay the skids on the ground, surfaced side down. Divide the skids into thirds. At each third point, cut notches about 6" wide and 2" deep. These are to accommodate the uprights posts that keep the cabin off the ground. The next step is to raise and level the skids. First, decide the height you want your cabin floor to be off the ground. Don't forget to take into account the thickness of the floor and joists (6¾"). Then take two pieces of scrap boards and nail them to the end of one of the skids as shown in Fig. 2. Swing them apart until you have the desired height, then repeat the entire procedure to the other side, making sure the skid is level. When that is done, dig 2 holes directly under the notches, deep enough to remove the sod layer and large enough to accommodate a rock with a flat surface at least 6" in diameter (cement pier blocks can be substituted). Make sure the rock is at least 2" above the surface. Then measure the distance between the rock and notch and cut and peel a post about equal to the width of the notch. If you find that the skid isn't perfectly level, shim the post at the notch (a wood shingle works well). Repeat the entire raising operation to the other skid, making sure that the centre of one skid is exactly 4' 8" away from the other and that they are mutually level.

FIGURE 2



The next step is to prepare the perimeter floor joists. Select 5 ten foot long 2" by 6"s that are relatively straight. Set your protractor square to 54° and lay out five 9' lengths with 54° angles at either end. Place the joists as shown in the floor plan (Fig. 4), fastening the ends lightly, with 2" nails. Juggle the joists around until they form an accurate pentagon, then dig holes under the three points shown, and lay rocks and posts as was done on the skids. When this is done, secure the ends with 2 4" nails each (Fig. 3). Make sure the joists are level with respect to each other. A little precision and time here will save hours of frustration later.

FIGURE 3



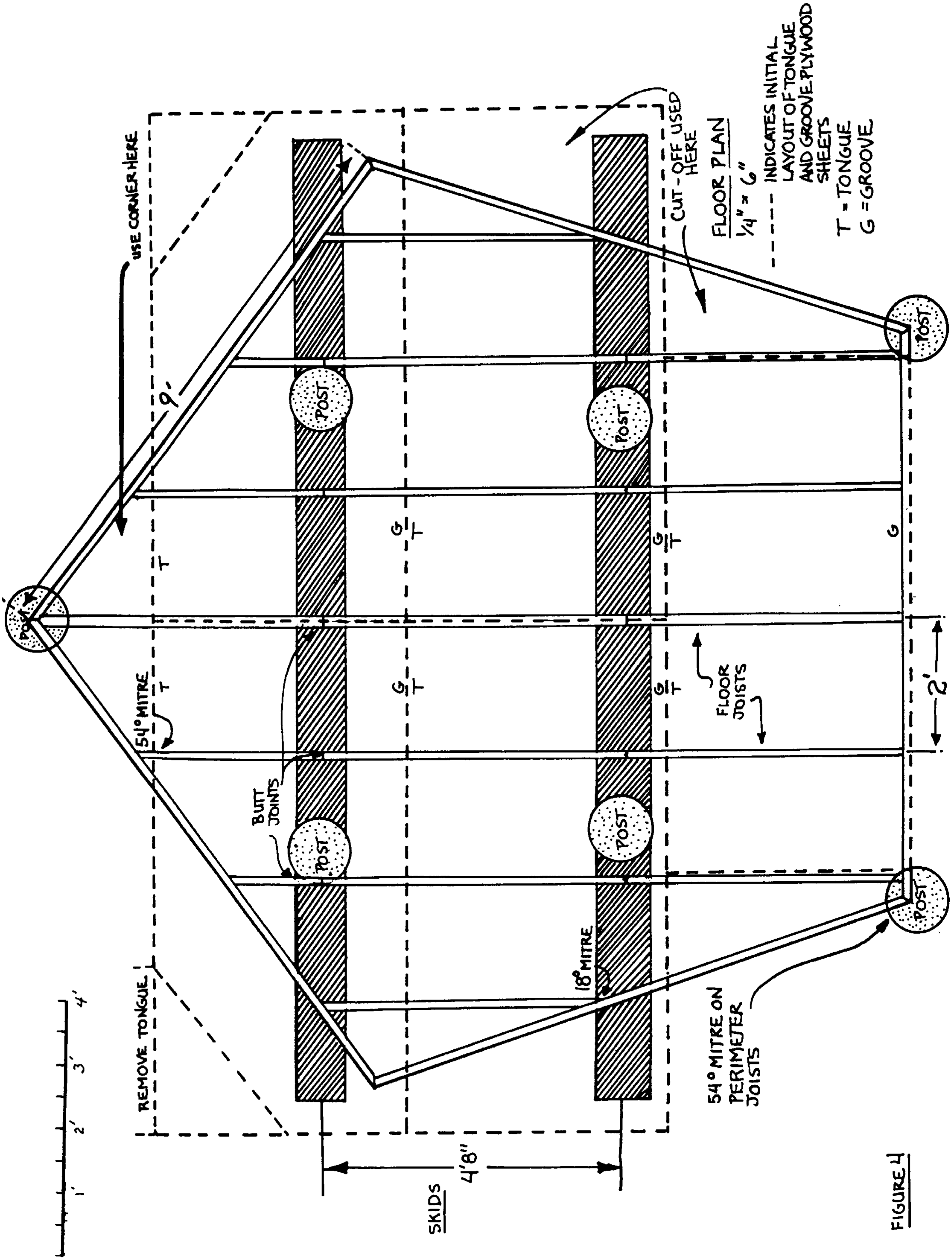
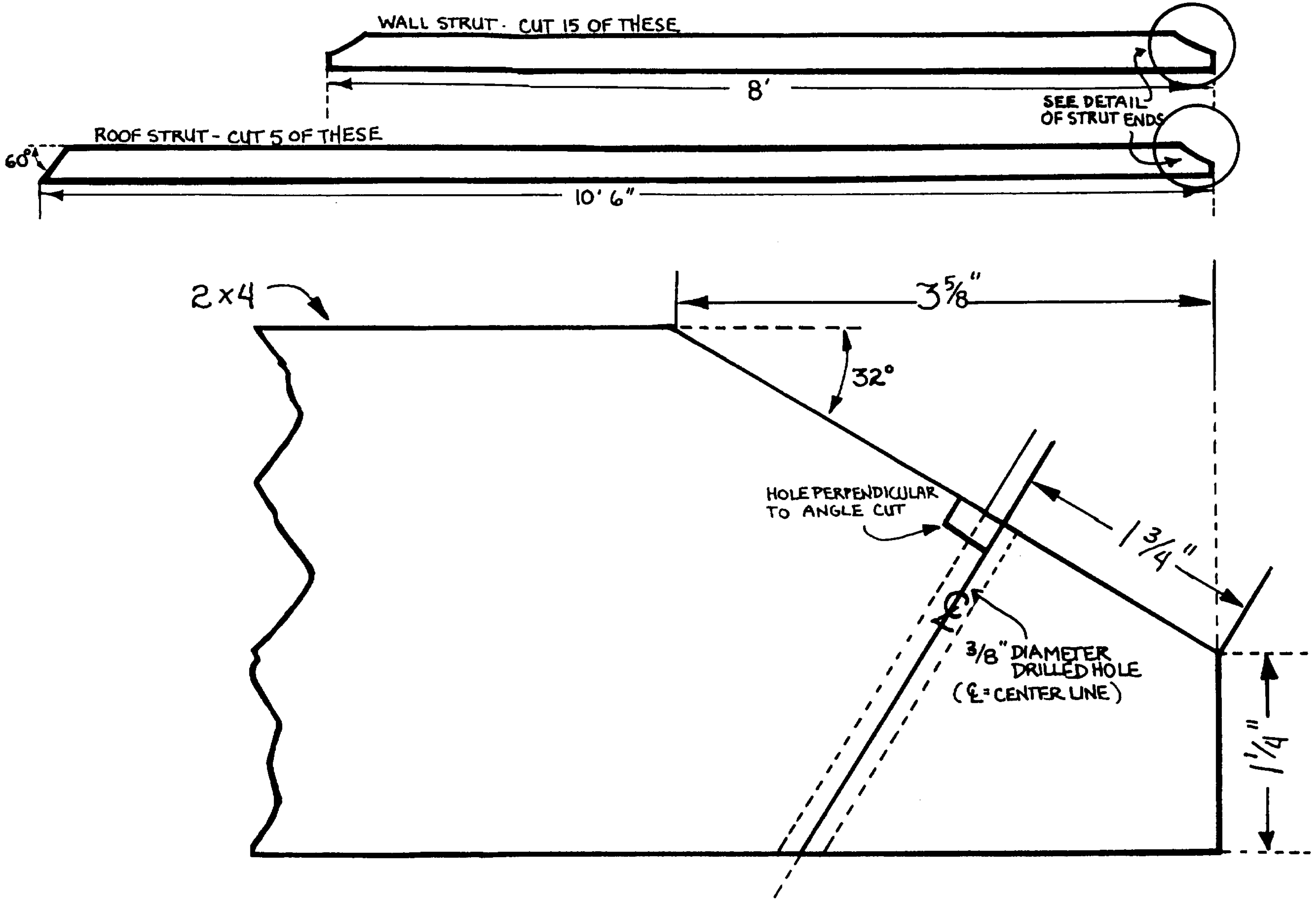
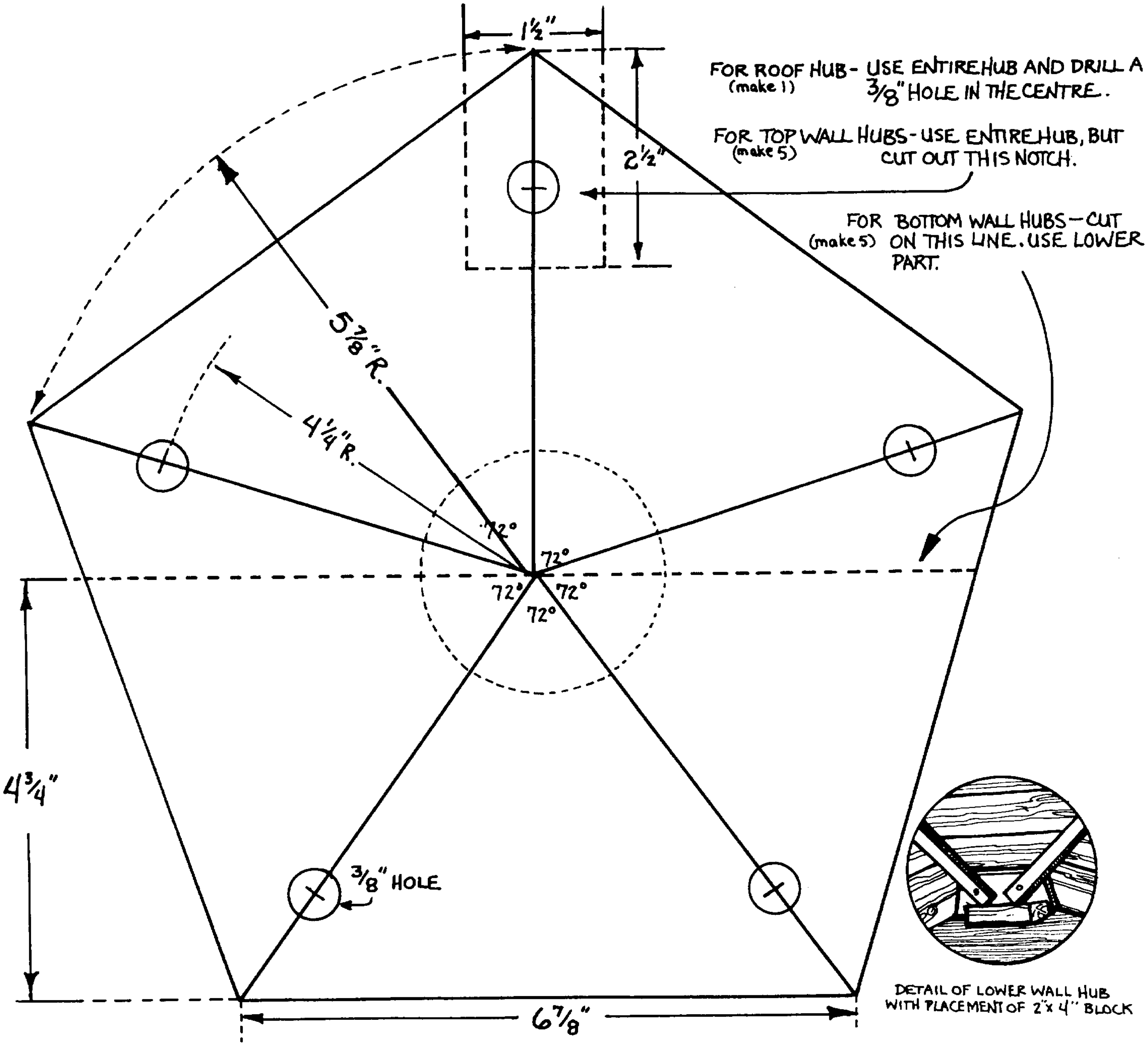

USE CORNER HERE
9'
CUT-OFF USED HERE
FLOOR PLAN
1/4" = 6"
- - - - INDICATES INITIAL LAYOUT OF TONGUE AND GROOVE PLYWOOD SHEETS
T = TONGUE
G = GROOVE
POST
POST
POST
POST
POST
POST
POST
POST
T
T
T
G
T
G
T
G
T
G
T
G
54° MITRE
BUTT JOINTS
FLOOR JOISTS
2'
REMOVE TONGUE
18° MITRE
54° MITRE ON PERIMETER JOISTS
4'8"
SKIDS
1'
2'
3'
4'

FIGURE 4


WALL STRUT · CUT 15 OF THESE
8'
SEE DETAIL OF STRUT ENDS
ROOF STRUT - CUT 5 OF THESE
60°
10' 6"
2x4
3⅝"
32°
HOLE PERPENDICULAR TO ANGLE CUT
1¾"
3/8" DIAMETER DRILLED HOLE (℄ = CENTER LINE)
1¼"

DETAIL OF STRUT ENDS TEMPLATE ~ FULLSIZE

FIGURE 5



FOR ROOF HUB - USE ENTIRE HUB AND DRILL A ⅜" HOLE IN THE CENTRE.
(make 1)

FOR TOP WALL HUBS - USE ENTIRE HUB, BUT CUT OUT THIS NOTCH.
(make 5)

FOR BOTTOM WALL HUBS — CUT ON THIS LINE. USE LOWER PART.
(make 5)

DETAIL OF LOWER WALL HUB WITH PLACEMENT OF 2"x 4" BLOCK

FIGURE 6

Next, position the floor joists as shown in Fig. 4, and nail securely with two 4" nails. Notice that most of the joists (the five longest) are two pieces of wood joined at a skid. Here again, take time to level accurately.

We tried pre-fabricating the floor, which proved to be very time consuming. Besides, you have to be extremely accurate as one slightly curved cut can result in strange gaps in the finished floor. A better method, we found, was to simply lay the 4' by 8' sheets of plywood (as illustrated by the dotted lines on the floor plan, Fig. 4) and saw around the perimeter of the floor. Before you saw though, nail the floor with 2" flooring or common nails on 8" centres. You should use the cheap hard-point saw for cutting plywood, because the glue used in laminating tends to dull saws very quickly. Use the plywood you cut off to form the 4 remaining pieces of the floor (as indicated) and for the hubs. Don't forget to check for level as you go along.

Fabrication of Hubs and Struts

Cut and drill the hubs and struts as shown in Figs. 5 and 6. Two people can reduce preparation time here. The hubs can be drilled five at a time if they are clamped together Note: a hole should be drilled through the centre of the roof hub for a safety rope (which will be explained later). Two people working in harmony should be able to prepare all the hubs and struts in about 2 hours. The next step is all fun. Assemble the struts and hubs according to your model (Fig. 1). Place the lower wall hubs on the floor. Do not tighten the nuts until all the struts are connected and the hubs are straight. To connect the frame to the floor, first find the centre of the floor as shown in Fig. 1. You must spot the lower wall hubs accurately in order for all the angles to be true. To do that, measure exactly 85½" from the centre to all five points. Place the inside edge of the lower wall hubs centred on that mark, and nail them to the floor. Then block both sides of the hub with 5" long 2 by 4's and nail them too. A way to check the whole assembly is to check the top struts for level. Twist the hubs until levelling is achieved evenly around the perimeter.

Loosely bolt the five roof struts to the roof hub. Cut a pole exactly 137¾" long and nail a 2" nail halfway into the centre of one end. Insert the nail into the hole in the centre of the roof hub. Then hoist the entire assembly, fitting the roof struts into the notches of the top wall hubs, up until the butt of the pole rests exactly on the centre mark on the floor. Temporarily nail the pole into the floor, remembering that it will have to be removed later. Nail the struts to the hubs, then tighten the nuts at the peak. The overhang from the struts forms the basis of the eaves. Measure, cut, and nail the "rafters" as shown in Fig. 8. When that is done, the support pole can be safely removed.

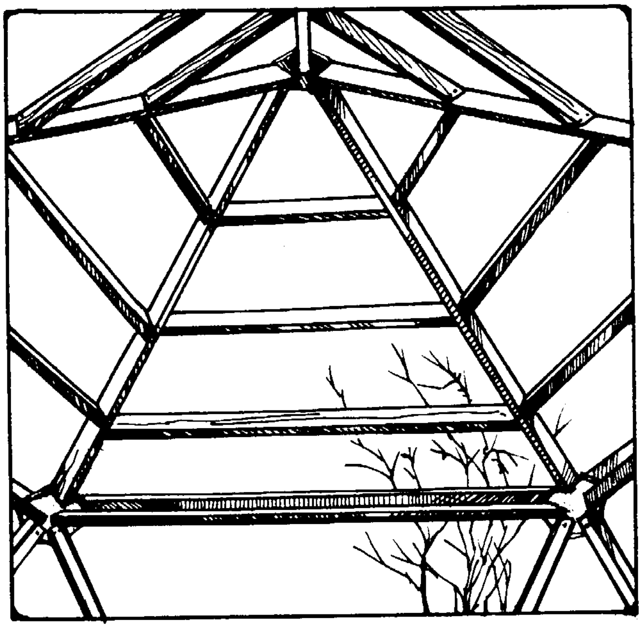
Sheathing

Normally, one starts the sheathing with the roof, the reason being that once it's finished, it doesn't matter whether or not it rains, you can still work on the walls. However, we did just that, and when it came to sheathing the very top of the walls, we found the space between the overhang and the wall was not large enough to swing a hammer! So, before you start on the roof, nail one board of sheathing around the top of the walls.

Before you begin to sheath the roof, nail a board of shiplap around the very perimeter of the roof struts to provide a nailing surface for the very ends of the sheathing boards. It should be mentioned that, in the interest of safety, a panic rope should be installed. Tie a ¼" rope, about 12' long, to a 7" long stout stick. Pass the free end through the hole in the roof hub, then nail the stick into the hub (to counter gravity). This rope should always be near the person working on the roof so that it can be grabbed at in a hurry. Start sheathing the roof from the centre of each section of the roof, working out to either side. Here again, two people working together should be able to sheath the roof in 2 days. Our method was to have one person on the roof marking the angles and nailing the boards, the other person marking the lengths and cutting. If rain seems imminent, you should waterproof the roof as soon as possible. First cut holes for the stovepipe "jack" assembly, skylights and vents as required, then nail the above on. A vent might be desirable during the summer but during the winter, it just lets out heat. An off-on device would be ideal. Install insulation if you want it (see section on insulating). A serviceable one-season temporary roof can be made with two layers of roofing paper. Start by sealing all the nails used to secure the vent, etc, with roofing cement. Staple the two layers of roofing material, starting from the bottom, overlapping 6". When you get to a chimney jack or whatever, cut an oversized hole, not so big that it extends over the flange. Then liberally cement the paper to the flange. If you get confused while roofing, just "pretend' that you are a drop of falling water.

When the roll roofing is in place, cut "shingles" out of the scraps about one foot square, and staple them to the

FIGURE 7



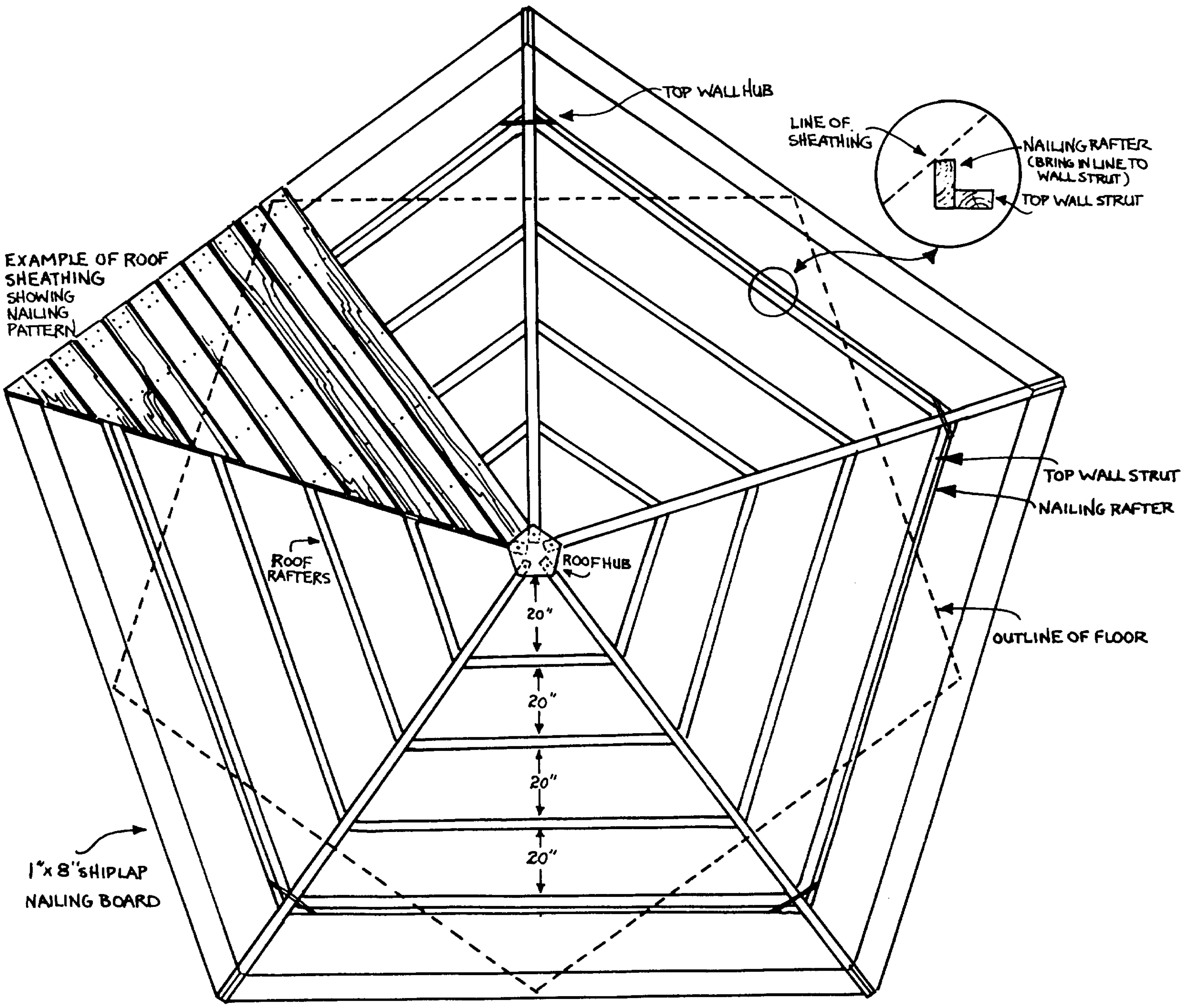

TOP WALL HUB
LINE OF SHEATHING
NAILING RAFTER (BRING IN LINE TO WALL STRUT)
TOP WALL STRUT
EXAMPLE OF ROOF SHEATHING SHOWING NAILING PATTERN
ROOF RAFTERS
ROOF HUB
TOP WALL STRUT
NAILING RAFTER
20"
20"
20"
20"
OUTLINE OF FLOOR
1"x 8" SHIPLAP NAILING BOARD

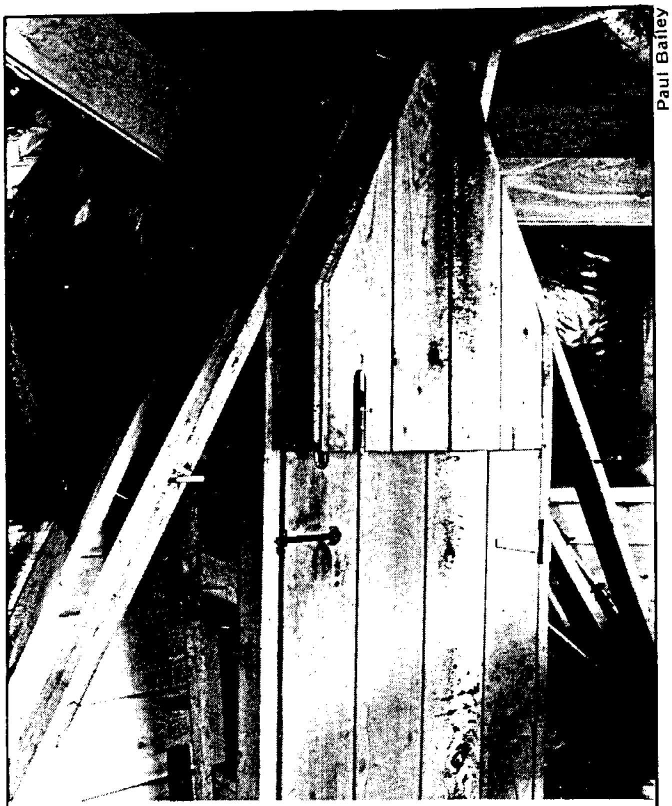
FIGURE 8

intersecting edges of the roof sections, from the bottom up, overlapping 6". When you are all done, no staples should be exposed except at the top. This temporary roof has proved itself through one Vancouver Island rainy season on two cabins, without leaking a drop. When installing a permanent roof, just use the roofing paper covered over by the roofing material. To waterproof the peak, cut an oversized hub (about 1' on an edge) out of ½" plywood, and bolt it on to the existing roof hub, using extra nuts and washers. Cement the nuts with roofing cement. The safety rope should be passed between the two hubs so it can still be used. Cover the whole cap with a layer of 4 mil. polyethylene film. A note about snow. The roof has been designed to withstand 40 pounds per square foot. We have measured 24" of snow on the roof without adverse effects. (1" of snow = 1 lb. per sq. ft.).

Before you start to sheath the walls, decide exactly where you want the windows and door. The door must be put in one of the triangles with the base on the floor, not the point. Leave one side open (not the door side) to sheath last, so you can conveniently use the elevation of the floor as a saw-horse in the event that you don't have one. It should be mentioned that any acceptable sheathing material can be used instead of shiplap. Shiplap was chosen because when it shrinks, you don't have to look at tarpaper between the cracks. For waterproofing purposes, sheath so the lap is under the board above it. Sheath from the top, where you nailed the first board earlier; from the bottom, on the other sections. Hacksaw the hub bolts just above the nuts so the sheathing will fit properly. A fast way to sheath the walls is to have two people hold up the board, one on each side. Each person is responsible for marking, cutting and nailing, his/her side. When you get to where you marked the windows, either leave a hole or build a window frame out of 2 by 4's and nail sheathing to it. One word of caution: never cut into the supporting struts! They are all that holds the roof up. The outside of the walls should be covered with one layer of roofing paper. Although the eaves are long enough to protect the walls from rain, there might be a wind which could blow moisture onto the walls. Just roll the paper out, overlapping 6" and working from the bottom up. Cut it and staple it in place. Insulation and a permanent covering can later be installed over the paper.

There are two ways a door may be installed. One is to fit two parallel uprights in the triangle and hang a door from them. The only problem is that the door is hung at an angle, so it closes with considerable force. This could be remedied with a hydraulic screendoor closer, but who wants to look at that? A better way is to build an upright frame and hang the door vertically. Because of the triangular shape of the doorway, a rectangular door wouldn't fit the frame. So, a door must be built to fit the frame. A serviceable door can be made out of shiplap lumber. Trace the outline of the door and transfer it to a few boards laid together. Make two thicknesses, one vertical and one horizontal, and nail them together. A little extra work and you can make a Dutch door (Fig. 9).

The holes that are left for windows can be temporarily covered with 4-mil poly reinforced with lath strips, or permanent windows can be installed. Used rectangular windows will fit into the wall sections that originate at the points of the floor. They can be installed in the other sections as well, but they would have to be rather close to the floor or very small. Instead, triangular windows can be installed as shown in Fig. 10.



Paul Bailey

FIGURE 9

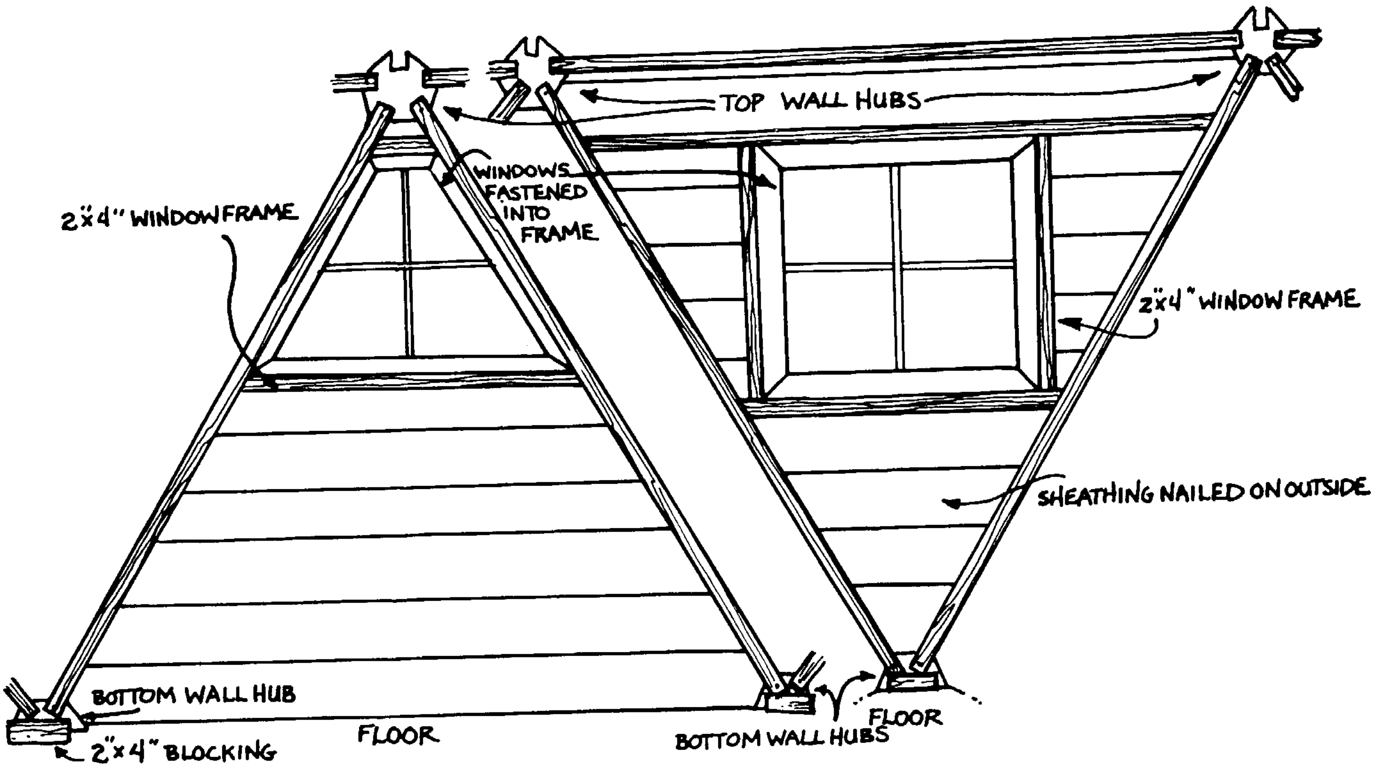
AN IDEA FOR A DUTCH-DOOR AND FRAME. NOTE HORIZONTAL SUPPORTS. TOP OF DOOR FRAME CAN SUPPORT CROSS-LOFT POLE.

Insulation and Covering

Insulation can be installed in the conventional manner (fibreglass stapled between struts on the inside) or it can be installed on the outside. The problem with inside insulation is that it has to be covered on the inside and inside covering cuts down on the amount of room inside. If the insulation is on the outside, you can install shelving in the "V" formed by the struts (Fig. 11), plus you have an attractive woodgrain interior finish from the shiplap sheathing.

The roof must be insulated with rigid panels but the walls and floor can be insulated with fibreglass. First, find out what the insulation requirements are for your area, then obtain the amount of insulation needed according to the materials list. For the roof, nail lath strips that are the thickness of the solid insulation, horizontally spaced the distance of the width of the permanent roofing material nail spacing. Tack in the insulation and then nail the roof covering over it, be it shingles, roll roofing, etc. The principle is the same for the walls. Just make sure the paper backing (vapour barrier) on the fibreglass insulation is next

FIGURE 10



to the sheathing. For the floor, buy insulation 2' wide, then press it up between the joists, making sure the paper backing is next to the floor. Covering can be just about anything as long as it's waterproof. Some ideas are: cedar shakes, cedar shingles, board and battens, and asphalt shingles.

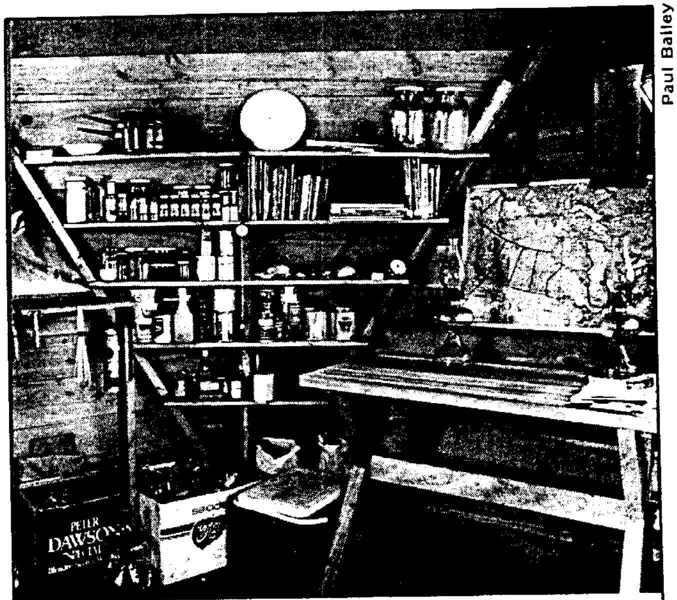
Miscellaneous

The roof is high enough for the installation of a storage loft. Poles or dimension lumber can be used. Lay the pole from any 2 upper wall hubs, securing it with a 2 by 4 block underneath. Supports can be screwed into the roof struts or poles can go to the floor. Horizontal supports should be installed every two feet, nailed to the top wall strut. Planks may then be laid over the framework. Warning: it gets quite warm up on the loft so don't store any perishables or musical instruments there.

The cabin described has a floor area of 140 square feet, quite adequate for one person. By increasing the floor perimeter one foot in length for each side, an area of 172 square feet with an additional space provided in a ½ loft, appears adequate for 2 compatible persons. This is the practical upper size limit to the eco-cabin design. If incompatibility is inevitable, then perhaps 2 of the smaller cabins interconnected but spatially independent may prove to be more viable.

By using more basic structural elements, poles, etc., the eco-cabin could also serve as a crop shelter, animal housing or tool shed, sauna, out-house, etc.

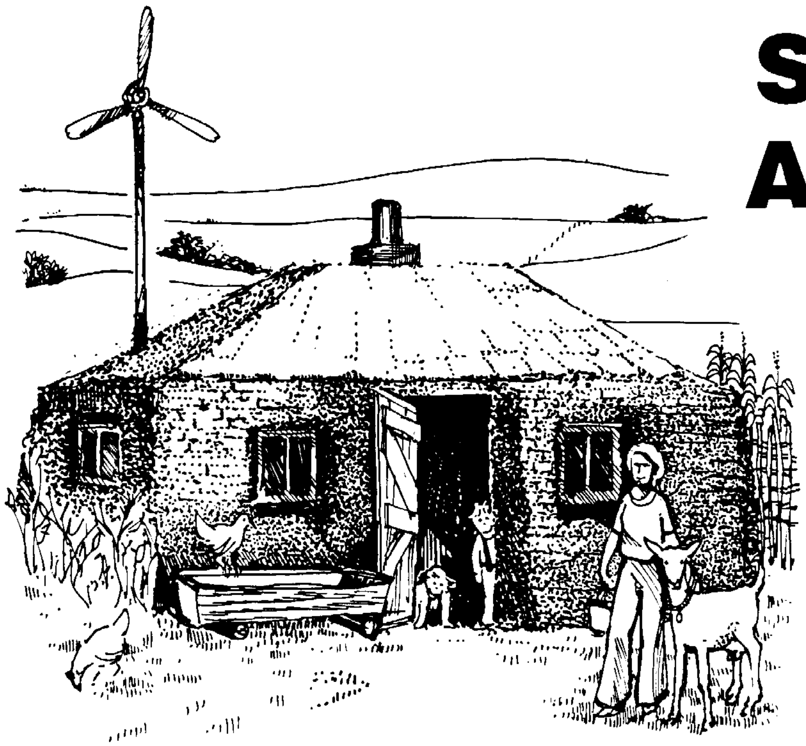
If you have any specific questions or want more detailed plans for insulating, roofing, and exterior finishing, write: Eco-Cabin, Greenpeace Experimental Farm, General Delivery, Denman Island, B.C. V0R 1T0, Canada


Paul Bailey

AN INTERIOR SHOT OF ECO-CABIN. NOTE THE SHELVING IS SET INTO STRUTS.

Subsistence Architecture

by W.C. Tinkess



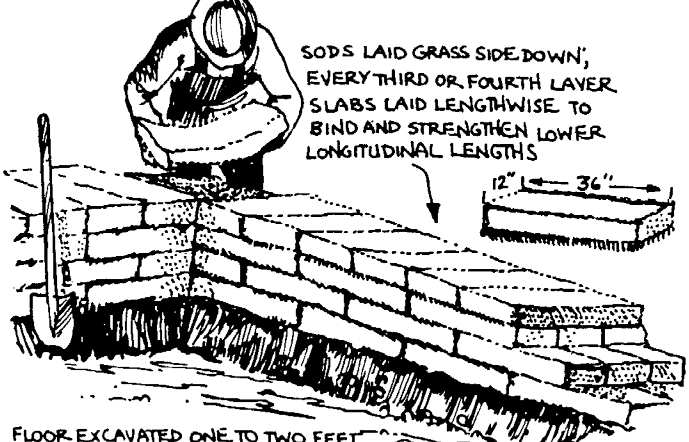
Sod Construction

Sod construction, in contrast to either loose earth or excavated holes, is distinctive. The sod blocks were, and are, employed as actual building blocks. This method of structuring was found in the British Isles, Scanadinavia, and across northern Europe. Sod and/or earth was used by the Vikings, and remnants have been located in Greenland and Iceland. The earliest authentic sod structures, excavated in Newfoundland, date from approximately 1000 A.D.

The attributes of earth/sod – especially the insulation value – have been known for some thousands of years. The insulation value of two inches of sod/earth is said to be equivalent to one inch of fibreglass.

In true sod construction, the use of wood was minimal, with the sole exception of the rafters. Pieces of sod were used and laid like bricks or flat stones. The sod dwelling was usually 12, 14, or 16 feet wide and 16, 18, or 20 feet long. The size was largely dictated by the economics of heating. Fuel was scarce: wood often had to be hauled and coal was expensive. Certainly there was nothing pretentious about sod buildings, but they were warm in winter and cool in the sultry summer. There were few window and/or door openings in order to make the walls as stable as possible. From 40 to 60 tons of sod were required for the average structure. The sod was chosen from a relatively dry coulee, where the roots were long, tough and fibrous. The breaking plough was used to cut a furrow from 12 to 14 inches wide; the sod averaged four inches in thickness. Depending upon the builder, the type of building, and the conscientious care expended, these long furrows were then cut into 24, 30, or 36 inch long strips. For true sod construction, the latter was preferable. In many cases the floor was excavated one to two feet below the ground surface. This was not always the case, but since it was only common sense to use the sod from the site itself, this was quite common. It also effectively cut down the height of the walls and increased their stability, and made it easier to construct when standing on a wagon bed or box. This lowered floor was also warmer and more draft-free. In careful building, the corners were squared and perimeter lines were drawn. The virgin sods were then laid, always **grass side down** using three 12 inch by 36 inch slabs together. These were laid as smoothly and as accurately as possible, with the cracks and crevices levelled and filled with a spade or shovel. Three or four layers were thus laid like bricks; the adjoining ends of the sods were staggered, and particular care was taken at the all-important corners. Next, a layer of sod was placed crosswise to bind and tie the lower longitudinal lengths. Then the lengthwise layers were resumed. These alternate layers were built up until the walls

FIGURE 1


SODS LAID GRASS SIDE DOWN; EVERY THIRD OR FOURTH LAYER SLABS LAID LENGTHWISE TO BIND AND STRENGTHEN LOWER LONGITUDINAL LENGTHS
12"
36"
FLOOR EXCAVATED ONE TO TWO FEET

reached a height of six or seven feet. It was essential to have a gradual inward slope of both the outer and inner wall surfaces. This was roughly one inch for every foot rise in height. In this manner, the finished wall was about three feet thick at the base, and two feet thick at the top under the line of the rafter ends. With a six-foot high wall, stability was asssured and maintained, but there was a full seven feet of head-room because the floor was excavated one-foot deep.

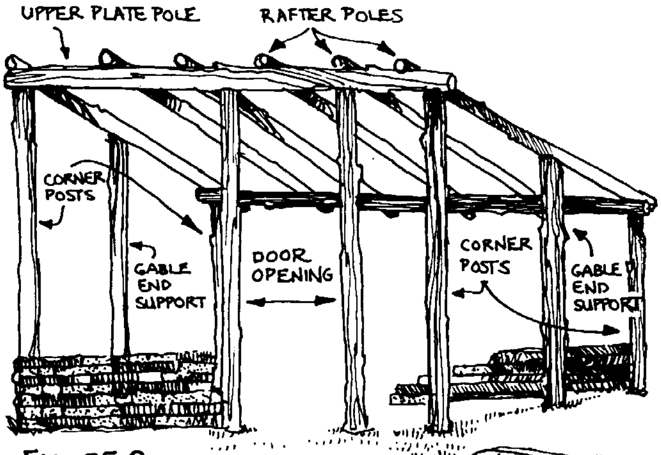


FIGURE 2
POLE FRAMEWORK- SHED ROOF

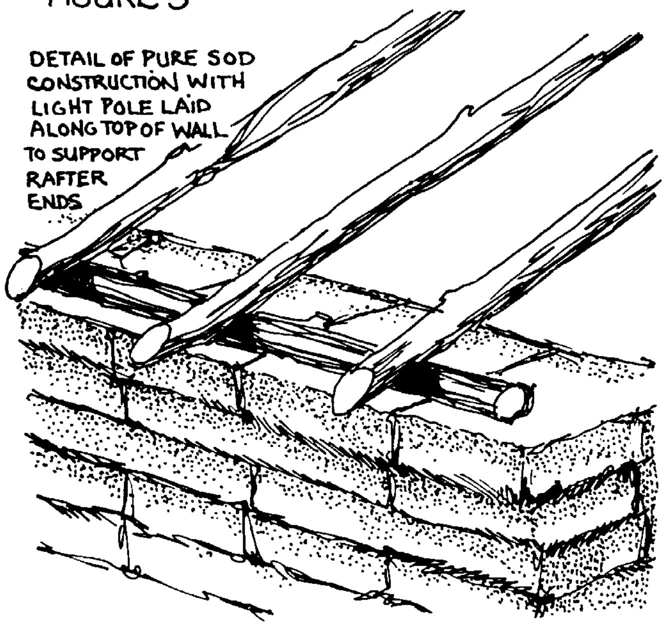
There were two methods of constructing a sod building. One was to erect an open frame work consisting of poles or posts planted at each corner, possibly at the appropriate door and window openings and perhaps the gable ends. These were then all joined together by the upper plate pole. The ends of the rafter poles rested **solidly** on this plate. Inevitably as the sod dried, there was shrinkage of the walls. Around both window and door openings this was of little or no concern, since these were easily re-plugged. The roof edges posed a more critical problem, because the walls shrank away from the roof or eaves. This meant that sod had to be continually cut to fit into and close the widening gap exposed. Since the rafters rested upon the ridged plate, they could not follow the settling of the walls. The other method did not call for posts, with the exception of central ridge supports when a gable roof was employed. The four walls were "pure sod build-up", minus the dubious contribution of built-in supporting posts. Here, the ends of the rafter poles rested directly upon the top of the solid sod embankment wall. The very slight rise of pitch directed the roof pressure downward. In some cases, a light pole loosely laid lengthwise along the top of the wall supported the rafter pole ends, and in this way the pressures were somewhat more evenly distributed throughout the wall. With the inevitable shrinking of the sods in the wall, the rafter ends and the entire roof settled as a unit, ensuring tightness without awkward repairs.

The door and windows were framed in wood and then built into the sod walls in the planned spaces. Over the window/door openings, small lengths of poles or logs were placed to bridge the space and to support the final layers of sods.

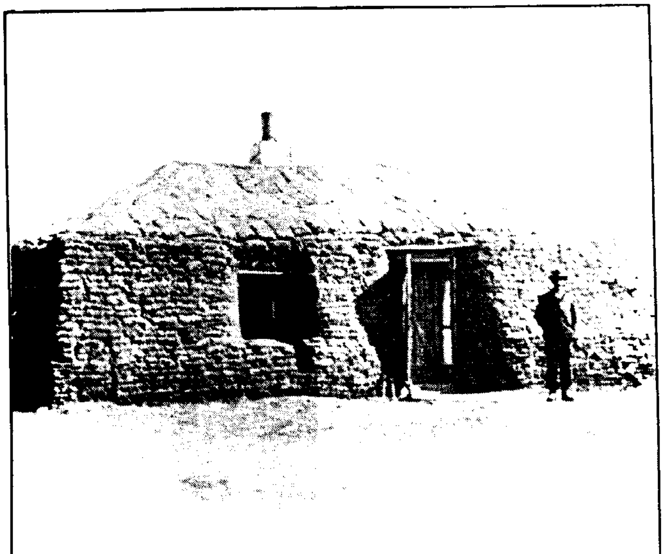
The most practical and convenient roof for a small soddy was the flattish "shed" type. The front walls were from six to eight feet high, and the rear from five to six feet. The rafter poles were simply laid across.

In larger structures of dwelling houses, the traditional gable was attempted. The extra weight rested upon the end walls, pressing downward, and should the building be hurried and sloppy, tended to produce outward pressures on the ends of the side walls. So, when using the gable, practical experience dictated that a stout post be planted either against each gable and inside, or actually built into the gable end walls to support the heavy ridge log or pole. To assist in bearing the weight of the roof, there were one or two extra posts in the interior of the building to support the central portions of the ridge pole or log. By its very nature, a sod-layered roof has tremendous weight problems, and its supports had to be sturdy. It has been estimated that about one hundred pounds per square foot was the ideal. However,

FIGURE 3

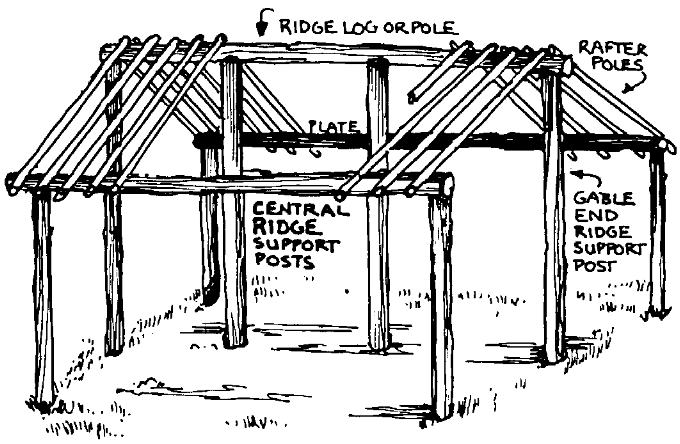


DETAIL OF PURE SOD CONSTRUCTION WITH LIGHT POLE LAID ALONG TOP OF WALL TO SUPPORT RAFTER ENDS



Built in 1906, this is a very well constructed "soddy". Several essential details should be noted. The thickness of the walls reveals the gradual inward slope of both surfaces of the wall. And notice the box made of plank filled with earth for the stove pipe, and the cottage-type roof. This is free-standing sod construction.

FIGURE 4
FRAMEWORK FOR GABLE ROOF



the settlers did not have the benefit of engineering formulas. From the river bottoms, the settlers obtained reasonably straight poplar poles. These were laid about 12 inches apart. Over the rafters was usually laid a layer of lighter branches and shrubbery. This in turn supported a layer of marsh or prairie hay or straw up to one foot in depth. Reasonable care was taken to see that the hay lay in a fairly even direction aligned from ridge to eave. When this was securely and evenly packed, then a double layer of sod was laid to make a total of eight inches of sod. Ultimately, this grew again as grass and further enhanced the roof's durability. Most of the literature and stories available mention the sordidness of these roofs, and that rain for a day outside meant about two days rain inside, as the roof leaked. Yet one wonders. With reasonable caution and care and without skimping on materials, such a well-made roof as outlined should give little trouble, except with prolonged tropical downpours.

The cottage-type roof illustrated in the first photograph ensured careful construction, and despite first impressions to the contrary, was ideal. The weight was borne equally by all four walls and the outward thrust was distributed equally as well. A minor benefit was that a much shorter ridge pole could be used. This, in turn, was supported by two posts planted inside the building interior under each end, with possibly a third being placed centrally. This roof had to be made in a wholesome manner to ensure satisfactory function.

No matter what type of roof was erected – whether shed, gable, cottage – the rise or the pitch was of necessity very gradual. Although the average builder lacked formal engineering knowledge, this instinctive low pitch minimized the outward thrusting pressures of the roof on the walls and held the sod in place securely.

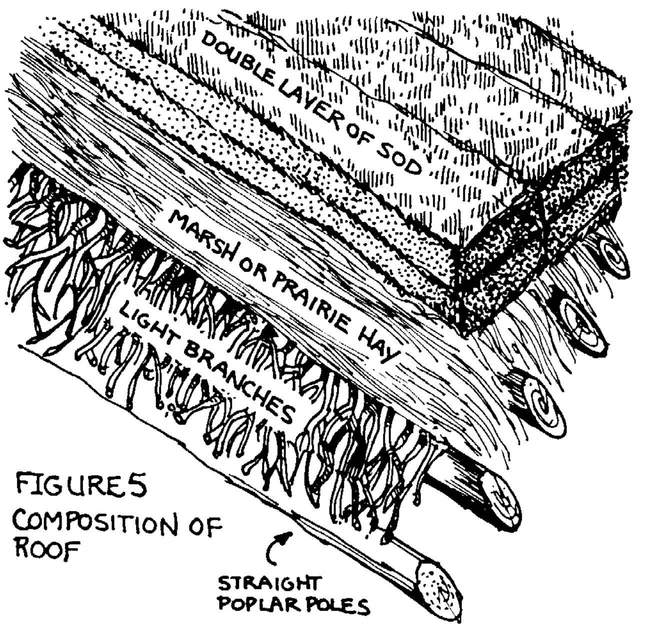
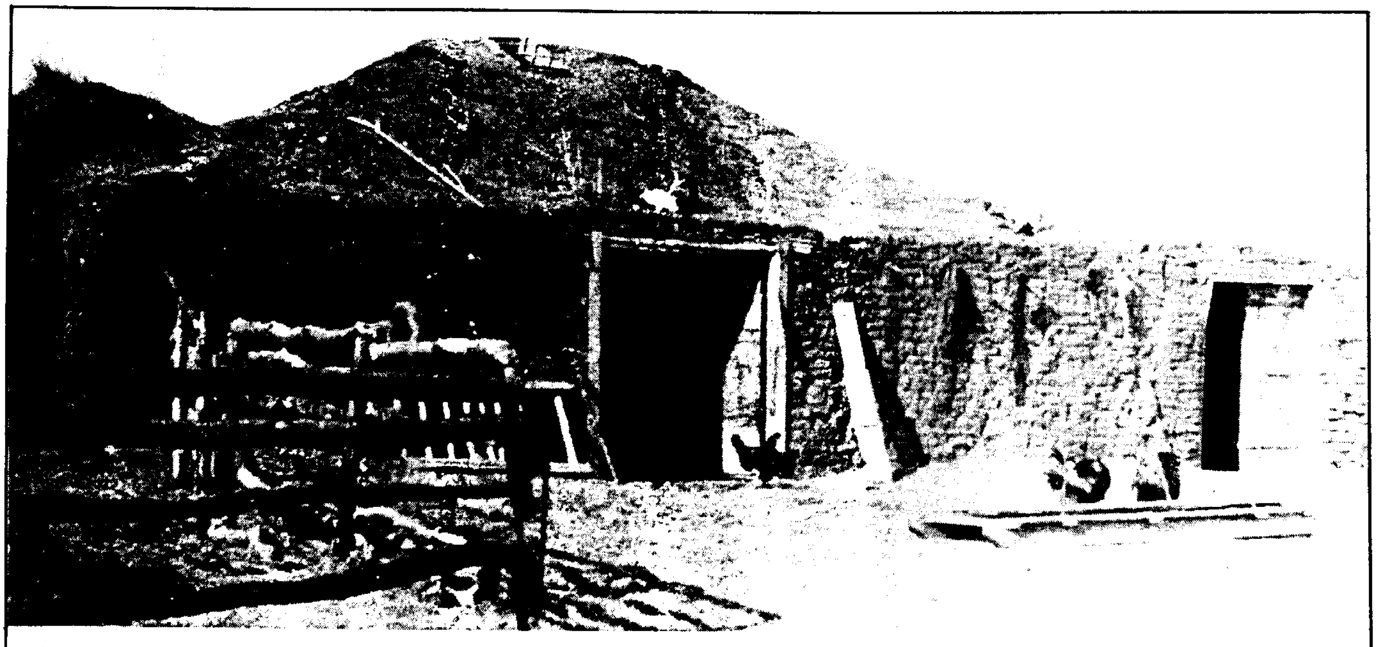
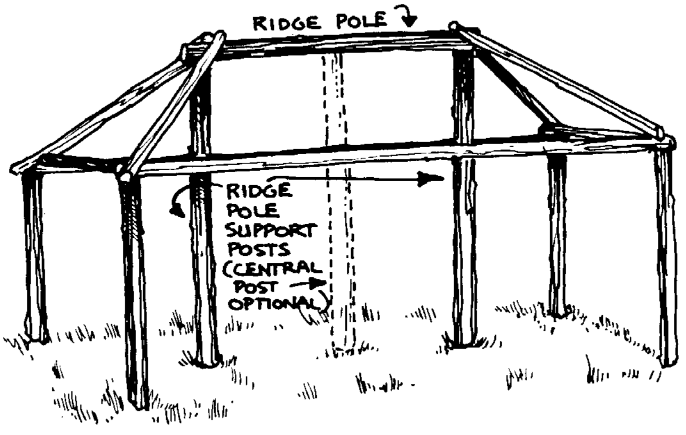


FIGURE 5
COMPOSITION OF ROOF



A stable built about 1908. Several interesting features are evident. Notice the "sky-light" in the peak of the roof. This is an established homestead, with a later addition to the original stable to the side. There is a possibility that this was a post framework with sod walls, since the walls are straighter than expected. Located near Anglia, Saskatchewan.

FIGURE 6
FRAMEWORK FOR COTTAGE ROOF


RIDGE POLE
RIDGE POLE SUPPORT POSTS (CENTRAL POST OPTIONAL)

Baled Straw Construction

In this age of mechanical balers, it requires very little imagination to see straw bales as building blocks and to visualize a structure. These "building blocks" must be quite firm, well shaped, and well tied. Such blocks or bales lend themselves most suitably to either square or rectangular construction. As with common brick and/or concrete block, the joints are staggered. Half-blocks are needed at the corners and window and door openings. These can be made by gently untying a full bale, removing the unwanted portion, and re-tying the shortened bale to fit the smaller area. Depending upon the conceptualization of the building – its use and relative permanency – the construction methods may vary. For a basic crude stable or poultry shed, the bales may be laid directly upon the ground, and this way suffice for several years. A much better method is to use a foundation or several widths of concrete blocks, concrete patio squares, or stone and cement on the ground site. The walls can then be a double course of the straw bales, with every second course being "headers" as in any common English bond brick construction. This results in a substantial wall – thick, secure, and tight. Take care to use only the better bales as noted. Joints will then be quite snug. Cracks or spaces between the courses may be judiciously stuffed with fine hay or straw. The corners are built in the conventional way of all brick construction. Openings for door and windows should be anticipated and the required half-bales prepared. Such openings may be framed of heavy plank or suitable boards, set and braced into place, with the resultant straw block wall built up to and embracing the openings. **Plates** on the wall tops under the roofs may be standard **scantling,** pinned into the under straw bale layers with long spikes. Upon these plates rest the rafters, as in any usual construction. The "shed-roof" may be the roof of ease and choice, but any type of roof is acceptable. Such roofs may be either sawn lumber and shingles, or asphalt roll roofing. Other circumstances may dictate that the roof be made of poles covered with light branches and a 12-inch depth of straw or hay loosely combed, the whole topped with four to eight inches of sod. To prevent livestock from nibbling the walls inside and out, a layer of cheaper poultry netting may be stretched over both wall aspects. A further improvement and long-range preservation may be secured by a coating of stucco or cement mortar over the walls inside and out. To complete this, place a polyethylene film over the basic concrete blocks and under the first course of the straw bales. This, with the addition of the stucco/mortar, preserves the walls from moisture, both ground and rain. Conceivably, a well-built straw-bale walled structure, with stucco coating,

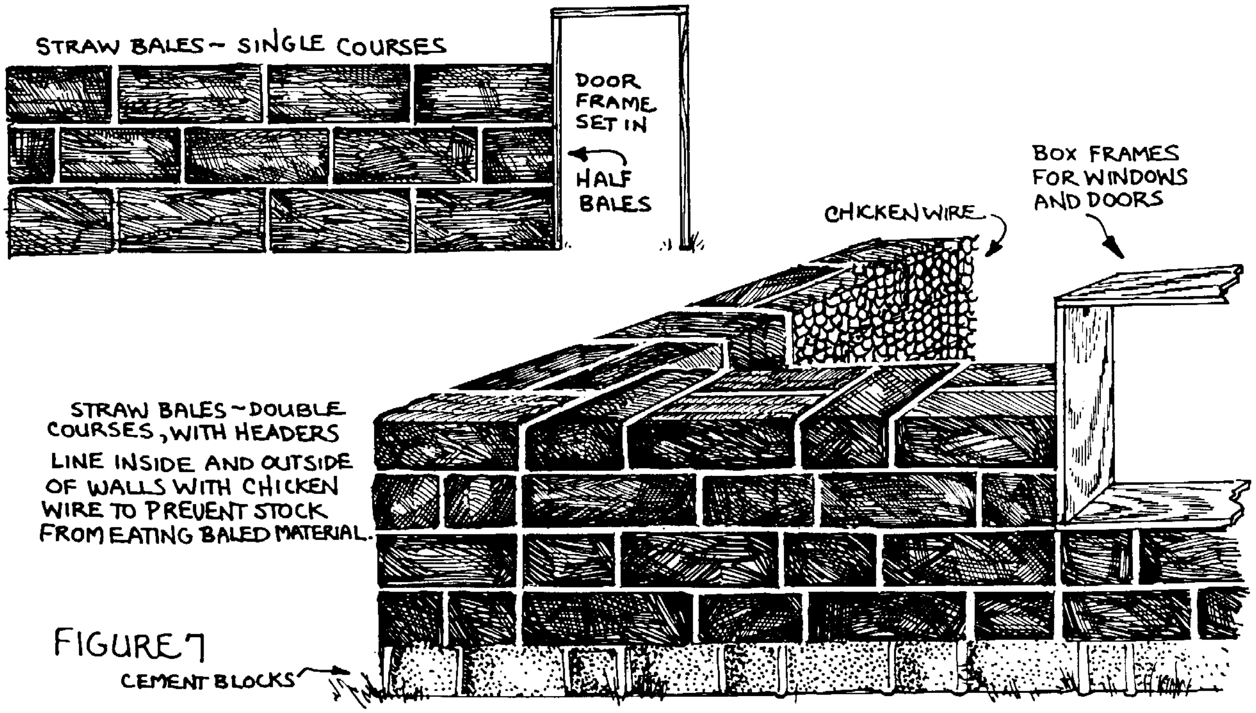
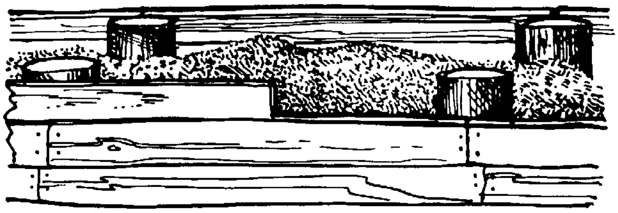

STRAW BALES ~ SINGLE COURSES
DOOR FRAME SET IN
HALF BALES
CHICKEN WIRE
BOX FRAMES FOR WINDOWS AND DOORS
STRAW BALES ~ DOUBLE COURSES, WITH HEADERS
LINE INSIDE AND OUTSIDE OF WALLS WITH CHICKEN WIRE TO PREVENT STOCK FROM EATING BALED MATERIAL.
CEMENT BLOCKS

FIGURE 7

could serve as a house, it would be warm in winter, and keep cool during the summer. No interior framework is required, with the possible exception of one or two planted posts to help support the roof ridge, especially if an earthen roof is used.

Loose Straw Construction

Loose straw/hay construction follows the techniques of building with rammed earth. Two lines of posts are dug and planted to form and to outline the wall. These two lines may be from 24 to 36 inches apart. The posts themselves should be approximately three feet apart, and as high as the structure is planned to be. Poultry netting is stretched and stapled to the inner aspect of the outer line of posts, and to the outer aspect of the inner line of posts. In other words, the two stretched layers of screening face each other, separated by two to three feet of space. Should a realtively permanent structure be required, it is advisable to place either concrete blocks or concrete slabs on the ground surface as a beginning, with perhaps a layer of black polyethylene film. Loose hay or straw is then placed within the "wall" between the two lines of posts and securely tamped. The material is placed in as evenly as possible without bunching and firmly tamped into a tight hard mass. If care is taken, this should result in a tight substantial wall. The tops of the outer line of posts may be connected and joined by a plate, either of sawn scantling or pole. This, of course, is for the rafter ends to rest and to build upon. Either the shed or the cottage-type of roof can be built to alleviate the building of gables. To facilitate the placement of doors and/or window openings, several posts may have to be moved closer together and door/window frames nailed directly thereon, resembling a box minus the top and bottom.



WHEN BOARDS ARE USED AS WALLS, SAWDUST MAY BE USED AS FILLER.

In the case of a window, the straw is paced tightly underneath the "box". The screening should be stapled to the box frame and removed from the opening itself. This type of structure serves admirably for outbuildings such as poultry houses, goat sheds, small stables, and such. Incidentally, in place of the poultry netting or fencing, old boards, or even reasonably long straight branches or saplings may be used, all fastened to the respective faces of the posts. A coat of stucco or mortar may improve the usefulness immeasurably and prolong the life of the building. The interior can be covered with some form of plaster board, and the outer line of posts strapped and the covered with shingles, roll asphalt roofing, or siding to convert the building into quite a creditable cheap human home, serviceable for many years.

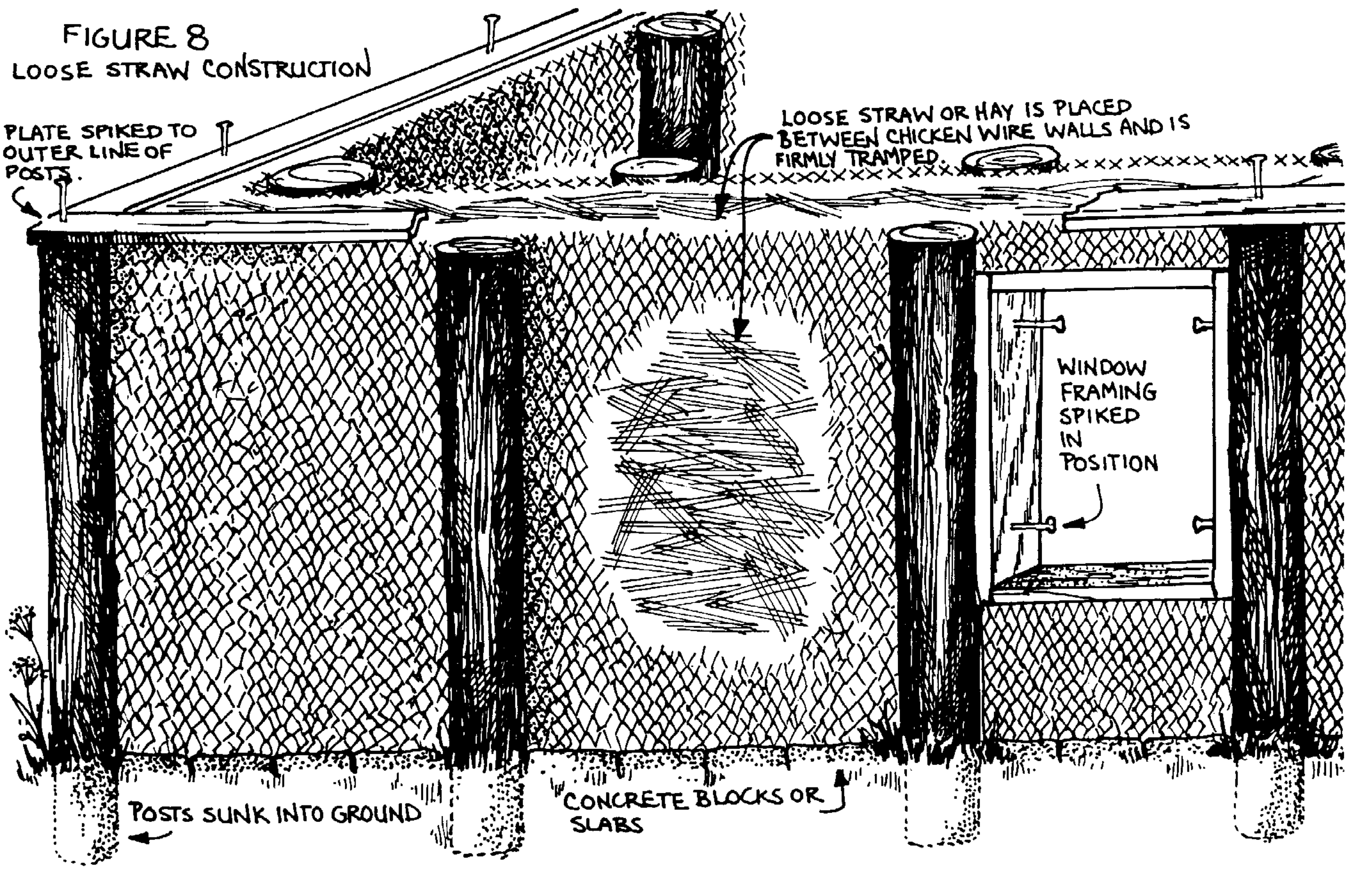
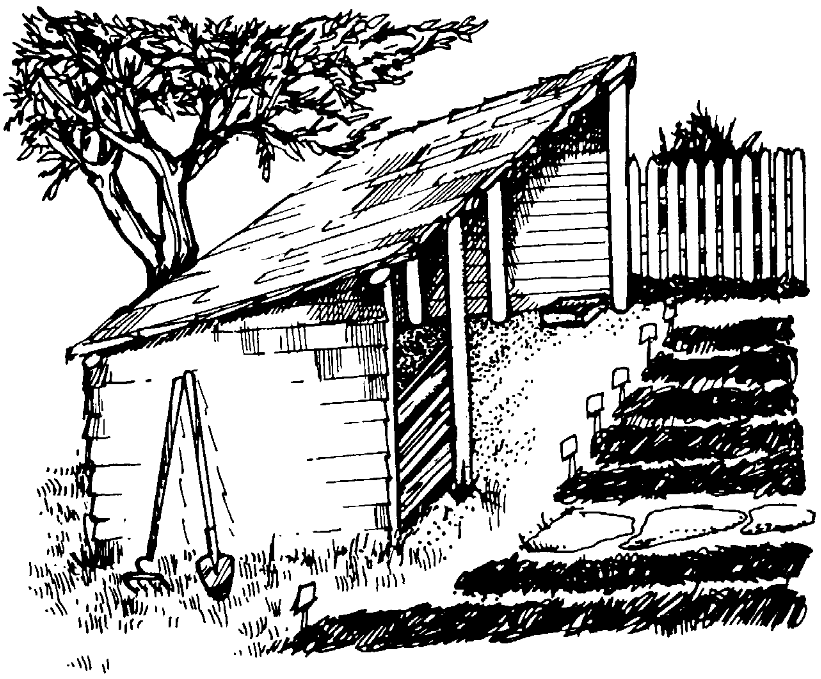


FIGURE 8
LOOSE STRAW CONSTRUCTION

PLATE SPIKED TO OUTER LINE OF POSTS.
LOOSE STRAW OR HAY IS PLACED BETWEEN CHICKEN WIRE WALLS AND IS FIRMLY TRAMPED.
WINDOW FRAMING SPIKED IN POSITION
POSTS SUNK INTO GROUND
CONCRETE BLOCKS OR SLABS

Post and Beam Design



by Norman Polster

When our family decided to build a house, we studied all possible designs, decided on post and beam, calculated structural members and built a model. I submitted our plan to Tom Michener, a mechanical engineer architect, for a structural analysis. From his study and Harry Parker's **Simplified Design of Structural Timber**, Wiley Press, 1967, $9.75, I learned some basic structural considerations.

Our house was designed for space for living, utilizing a 64 inch module, a 1:3 slope shake roof, 7 modules long and 4½ modules wide on two levels. Four inch square posts surround the house and 4" x 6" posts run down the centre.

The roof was designed to support 50 pounds on each square foot and the floor 40 pounds. The roof beams were 4" x 8" to span the 2½ modules of the living room. The beam height was then calculated as follows:

$$\begin{aligned} h &= 3L\sqrt{\frac{w}{bf}} \\ &= 3(13)\sqrt{\frac{250}{4(1600)}} \\ &= 7.7 \text{ inches} \end{aligned}$$

h–height of beam in inches
L–length of beam in feet
b–width of beam in inches
w–force on each foot of beam in pounds
f–fibre stress in wood in pounds per square inch (allowable stress is 1600 psi.)

If we had selected round beams, the diameter would have been:

$$\begin{aligned} D &= \sqrt[3]{\frac{48\,w\,L^2}{\pi f}} \\ &= \sqrt[3]{\frac{48\,(250)\,13^2}{\pi\,1600}} \\ &= 7.4'' \end{aligned}$$

D– diameter of round beams in inches

If we had used round beams they would have weighed 240 pounds, whereas our rectangular beams weighed only about 100 pounds.

The vertical force supporting the beam at each end is:

$$\begin{aligned} V &= \tfrac{1}{2}\,Lw \\ &= \tfrac{1}{2}(13)\,(250) \\ &= 1630 \text{ pounds} \end{aligned}$$

V–vertical force in pounds

The compressive stress on the beam where it rests on the 4" x 4" post is:

$$\begin{aligned} c &= \frac{V}{a} \\ &= \frac{1630}{16} \\ &= 102 \text{ psi} \end{aligned}$$

c–compressive stress in psi. (allowable stress is 400 psi.)
a – area in square inches

The compressive stress on the central floor beams where they meet over a 6" x 4" post is:

$$\begin{aligned} c &= \frac{1.8\,(1630)}{12} \\ &= 244 \text{ psi.} \end{aligned}$$

Note: 1.8 is the effect of both roof and floor loads.

The foundation under the central posts was made one foot square to support the roof and floor load of half the beam loads.

$$\begin{aligned} V &= \tfrac{1}{2}\,(24)\,(90)\,(5) \\ &= 5400 \text{ pounds} \end{aligned}$$

Note: the total width is 24'.

The stresses parallel to the grain along the central plane of a beam are:

$$q = \frac{1.5V}{bh}$$
$$= \frac{1.5\ (1630)}{(4)\ (8)}$$
$$= 76 \text{ psi.}$$

q–stress in psi. (allowable stress for fir is 120 psi.)

If we had used an 8" diameter round beam:

$$q = \frac{5.33V}{\pi D^2}$$
$$= \frac{5.33\ (1630)}{\pi 64}$$
$$= 43 \text{ psi.}$$

Our floor beams extend 5' to form a deck, the length length we might have extended the deck based on the allowable stress on the wood is:

$$L = 6.7h\sqrt{\frac{b}{w}}$$
$$= 6.7(8)\sqrt{\frac{4}{250}}$$
$$= 6.7'$$

Had we chosen a round beam this length would have been:

$$L = \sqrt{\frac{D^2\pi f}{192\ w}}$$
$$= \sqrt{\frac{8^3\pi(1600)}{192\ (250)}}$$
$$= 7.2'$$

Our tallest pole is 12 feet in the upper centre of the house and the allowable unsupported post 4 inches in width should not be more than 16 feet. The compressive stresses on the ten foot post in the lower centre of the house is:

$$c = \frac{V}{A}$$
$$= \frac{5400}{4 \times 6}$$
$$= 225 \text{ psi.}$$

c–compressive stress in psi. (allowable in fir is 1000 psi.)

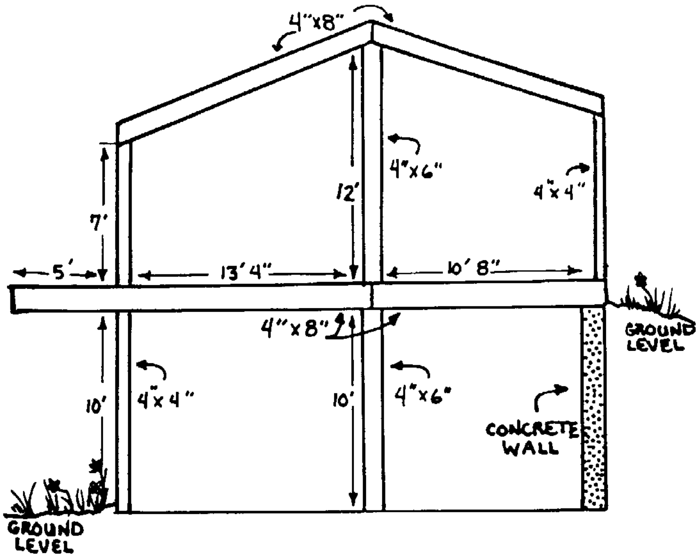
There is another calculated allowable stress:

$$c = \frac{3E}{\left(\frac{L}{D}\right)}$$
$$= \frac{.3(1,760,000)}{\left(\frac{(10)\ (12)}{(4)}\right)^2}$$
$$= 590 \text{ psi.}$$

E–modulus of elasticity–psi. (for fir this is 1,760,000 psi.)

D–smallest width of post-inches

There are other structural considerations in building a post-beam house, especially the diagonal bracing and attaching the beams to the posts. We put bracing in all solid walls, interior and exterior. To attach a beam to a post we used 12" x ½" lag screws and, where two beams joined over a post, an 18" x 2" x ¼" metal plate on top of the beams.



A Post and Beam Shed

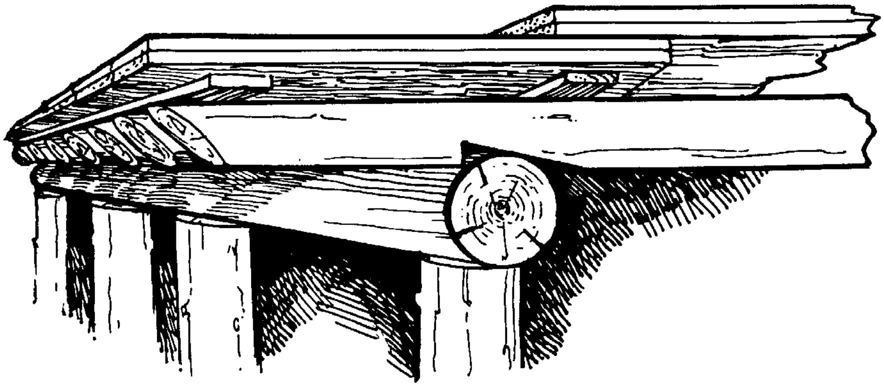
by Jur Bekker

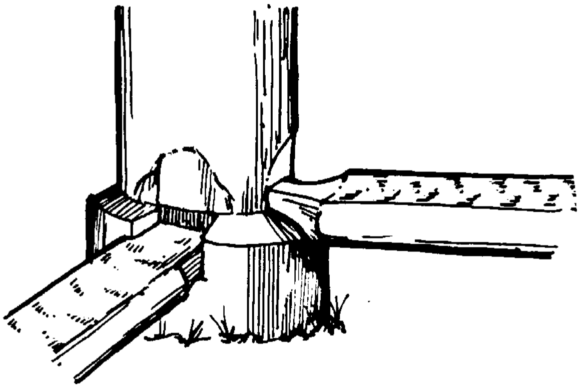
A couple of years ago I built an 18' x 24' post and beam shed. Since it has been such a useful building, I thought I might pass on the way I built it.

The shed was built to meet a variety of needs. At the time of building, we needed space to house our goats and to store hay. Eventually the shed will be used for wood storage and workspace.

After cutting down the trees in the area where the shed was going to be, I staked out the locations of the posts. To get a square, I used a string and checked the two diagnonals. When they are equal, the layout is square.

The posts stand on top of seasoned cedar foundation posts (1½' - 2' in diameter and 3' long) which are dug in, leaving about 6" above the ground. A 12" piece of 5/8" reinforcement rod, drilled 6" into both the foundation and posts, stabilizes them. For the posts I used 18" diameter fir and larch logs. I left the posts a little longer than needed. After erecting the posts, I snapped a horizontal (using a line level) chalkline on the posts and cut them off even, with a power saw. After the posts were up, I braced them





to each other and to trees and stumps with thin poles and 1" x 4"s.

For beams (horizontal members) I also used fir and larch logs (8" - 12" diameter.)

These beams were flattened where they sit on top of the posts. I drilled ¾" holes in the beams right over the posts. The holes go half way into the beam. A 7" spike was then driven into the hole with a heavy hammer. An old bolt, used as a drift pin, enabled me to drive the spike all the way to the bottom of the hole. This way, I did not have to use 12" spikes. For rafters, I used straight poles (larch, cedar and pine) with little taper, about 6" at the butt and 4" at the top. With a regular double bitted axe, I hewed a 2" wide flat face on one side of the rafters. This flat face later received the purlins.

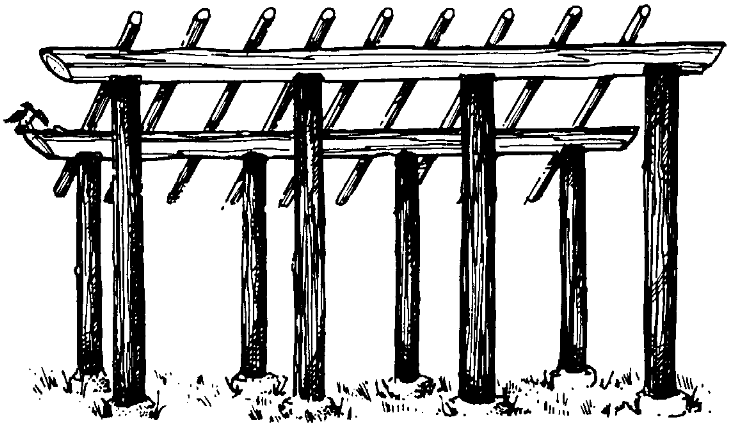
Over the beams I reduced the rafters to the same thickness (determined by the diameter of the thinnest rafter), so that the upper side of rafters ended up even. If they are not even, the purlins will not lie flat and this will cause difficulty with the shaking.

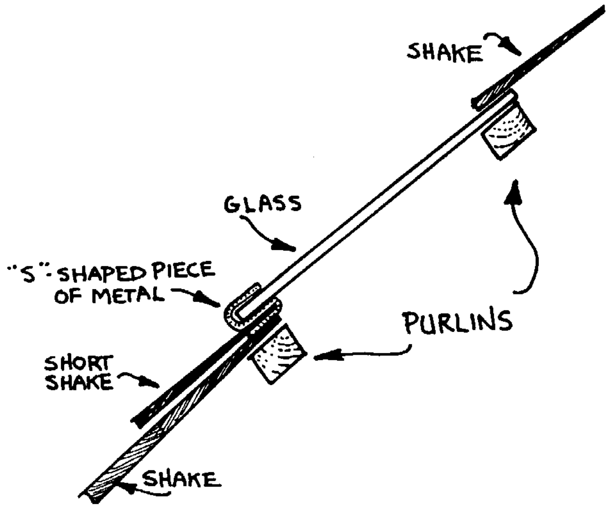
I chose a 1:3 pitch because I used shakes on the roof. Any flatter roof and it would have leaked.

For purlins (the boards that lie on top of the rafters and support the shakes), I used 1" x 4" rough white pine. For raising the posts and putting the beams on top of them, I used a tripod made from 15' cedar poles and a block and tackle.

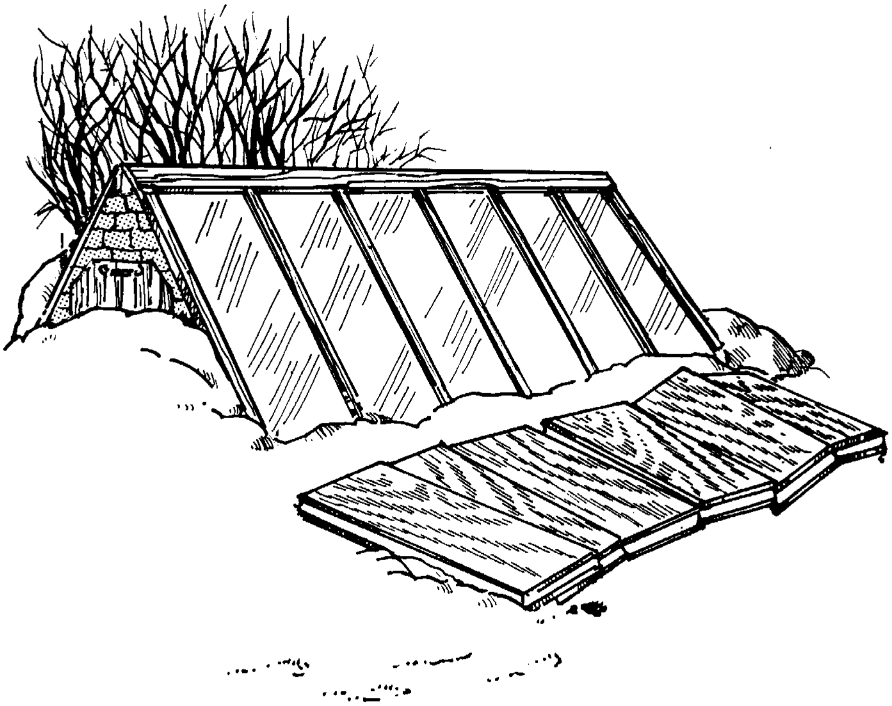
I did not put skylights in the roof and now I wish I had. I have put them in another building and it is very simple. I used pieces of flat car window and put them in the same way one would put on a shake on a roof. The only difference is that I put in 1" wide strips of flashing material (galvanized iron or aluminum) bent in an S-shape. One half stuck in the space between the shakes, the other half supporting the glass.

Although diagonal bracing is stronger, I did not use it because it gets in the way of doors and partitions. I put in horizontal braces, which were notched in.





The Sunpit Greenhouse



by Hal & Judy Hinds

Wintering in cold temperate, or more aptly, intemperate, parts of the world is guaranteed to be much more endurable if you combine a bit of autumn with a lot of spring inside a sun-heated, sunken greenhouse or Sunpit. In a nutshell, a rectangular hole about 4 feet deep is dug with the long axis running NE and SW. A concrete foundation is constructed against the walls of the hole and covered with a roof insulated all around except on the SE side which is fitted with plastic. In the east end a half-size door opens out, and although you have to bend down to enter the Sunpit, a full-size door would mean an exterior stairwell that would fill with snow and ice. In the west end there is a hatch, hinged at the bottom, that is opened for cross ventilation. Earth-heat and moisture rise from the floor and solar radiation through the plastic front heats the interior. Insulated panels cover the plastic at night and during prolonged periods of stormy weather, holding in the heat.

Because the temperature in the Sunpit greenhouse ranges ideally between 35° and 70° F, it is classed as a "cool" greenhouse, a type of structure capable of favouring a wider and more practical spectrum of plants than the tropical or semi-tropical greenhouse built above ground with wall-to-wall glass. The five major types of cultural activities we have tried successfully in the Sunpit indicate its possibilities: we have grown salad greens of several varieties all winter long in broad flats; we have brought a great range of beautiful plants into flower; we have forced many pots of bulbs; we have over-wintered and propagated tender plant material, especially herbs; and we have started flowers and vegetables from seed for the summer gardens. The potential for experimentation and enjoyment is endless.

The Excavation

The excavation for the Sunpit can either be dug by hand or by heavy equipment. We dug ours, four feet deep, nine feet wide and about 19 feet long. We were in no hurry, and used the soil dug from the excavation to fill potholes in the driveway and construct an elevated ramp to the barn. All the larger-than-fist-sized stones were set aside and were later embedded in the mortar of the foundation. Two trenches were also dug, both sloping away from the Sunpit. One trench carries a plastic water line and an electrical cable from the cellar of the house, while the other holds a four inch drainage pipe to carry off any extra water that might enter the Sunpit. The drain pipe goes under the foundation wall and the electrical/water line goes through the foundation in a 2-inch plastic pipe.

The Foundation

Once the trenches were filled, I squared off the excavation by delineating the corners of the forms with batten boards and strings. I decided to use the earthen sides of the excavation as the outer part of the form. In this way, I had only to construct the inner part of the form, carefully reinforced and braced across the centre, and a low form around the outer edge of the excavation where the final foundation would extend above ground level. I used recycled lumber for the foundation forms, plywood, old doors, old floor boards, etc.

Next was to pour the concrete, a big, one-day job. We rented a small gasoline-driven cement mixer for the event. We used a formula of 10 parts mixed sand and gravel to one part cement with enough water to make a rather runny mix. The stones from the hole were incorporated in the foundation as it was poured and one worker stood inside the excavation and pounded on the form to help settle the mortar around the stones. On the last loads we were careful to level the top of the foundation so that the sills of the superstructure would lie even all around. Just before the last batch set, I inserted two long bolts, thread end up, along each side. These bolts went into the concrete about two inches and were long enough to go up through the sill beams and be fitted with a washer and nut. Our mix of concrete cured rather slowly, but we were not in a hurry. It produced a strong set, and when the forms were removed about three weeks later, it could be seen that only a very few cavities were left unfilled by the concrete. It is best at this time to cover the floor of the pit with 3-4 inches of crushed rock to help drainage.

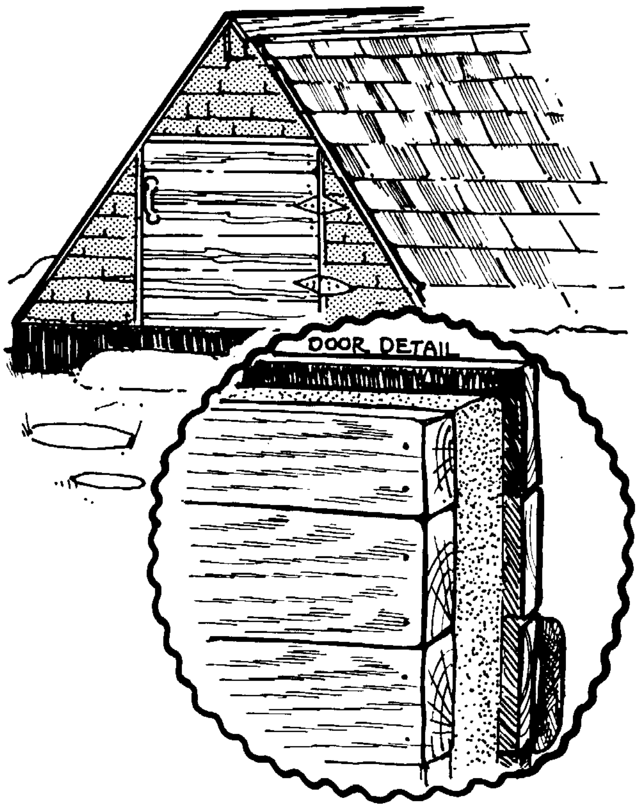
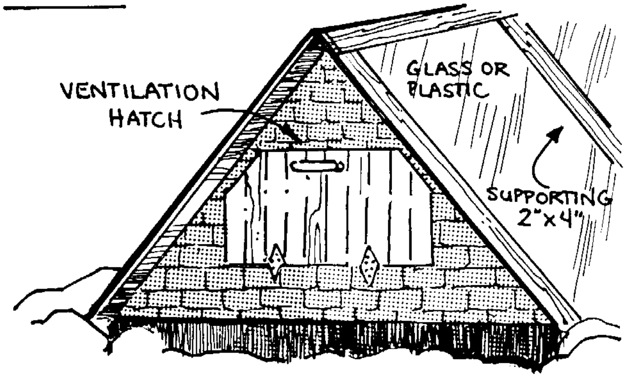


FIGURE 1

The Superstructure

The 4" x 4" sills were attached by drilling and countersinking the bolts, washers and nuts. The straightforward carpentry and the new, unplaned lumber that we splurged on made the job of building the superstructure move along very quickly. In one weekend the roof on the north side was boarded up and covered with tarpaper and shingles. The Sunpit really started to take on a finished look. The front side was covered with a layer of 6 mil plastic fastened down with lath strips. Later another layer was added inside producing a 2-inch space between. Inside the pit, the back side was boarded up and styrofoam pellets were used as insulation. Plastic sheeting was used liberally throughout to seal cracks between boards to keep the insulation from leaking out and as a vapour barrier. The ends of the Sunpit were treated in the same manner, and the door and hatch were built with a space for the pellets also. Styrofoam sheets would be easier to handle for the door and hatch, however.

FIGURE 2



The Panels

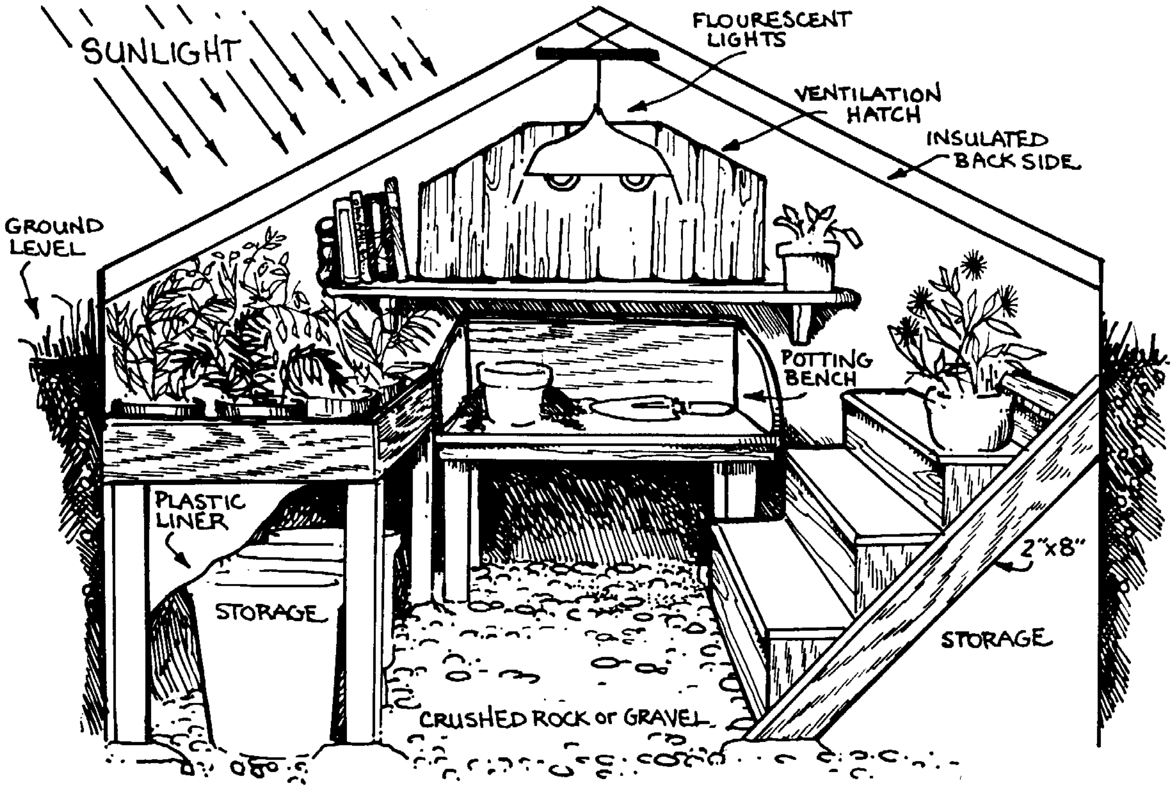
The insulating panels are styrofoam sandwiches. Three inch styrofoam sheets are bonded and bolted to two ¼-inch plywood sheets. The size of the panels will vary with the size of your Sunpit. We used five panels about 5 ft. by 3 ft. You might not need the carriage bolts if you do a careful bonding job. There are special caulking gun adhesives formulated just to bond styrofoam to wood. Make sure the adhesive and panel components are fairly warm before using. At first we tried fastening the panels to the superstructure with hinges at the bottom, but snow tended to pack in and spring the hinges, so it seems best in our climate to leave the panels loose. A canvas cover rolled down over the panels would make the Sunpit a little tighter and protect the panels from rain and snow damage.

The Interior

The success of the Sunpit is immediately apparent upon opening the door: the warm, moist, fragrant air; the mass of variegated foliage greens; the liberal sprinkling of such colours as cyclamen pink, delphinium blue, larkspur orange, snowdrop white, Christmas cactus red and primrose yellow. We used unplaned spruce and fir left over from the superstructure for the interior stagings.

On the left as you enter, underneath the plastic-covered southeast side, is a table three feet wide and four feet high, running the full eighteen foot length of the Sunpit. This table, or front bench, is supported by cedar poles resting on flat rocks, two poles on each corner and two front and back half way along. The entire structure was carefully leveled during the building and is anchored to the sills that rest on the concrete foundation. This bench is bordered all around by a six-inch wooden rim. Within the rim, forming the table top, are three-foot boards of random widths set apart about one inch for drainage. These boards are not

FIGURE 3



nailed down, but merely rest on two by fours that are attached to the bottom of the bench rim.

The extensive area underneath the front bench makes an ideal storage space for pots, soil ingredients, compost bucket, germination chamber and bulbs for forcing. Care must be taken to avoid drenching these materials with water from the plants above. The problem is easily solved by underlining the front bench with a sheet of 4 mil polyethylene plastic. It is stapled to the underside of the front rim and slopes gently down toward the back.

In the corner immediately to the right of the entrance I have a tub of water under the water faucet. This tub was cut with a chain saw from the bottom half of a wooden barrel and serves admirably as a water reservoir for watering the plants and also as a repository for my stock of watercress that I replant into our little brook each spring. Without this tub I would have to drain the Sunpit water line back to the cellar during frigid weather and turn it on again each time I wanted to fill my watering can.

The staging under the north roof is in the form of bleachers, three long shelves about a foot apart running nearly the full length of the Sunpit. Four 2" x 8" boards running diagonally from the back sill to the floor and resting again on flat rocks make up the supports for the shelves. The shelves are ordinary boards, eight inches wide and fourteen feet long, carefully leveled along their length and supported by brackets cut 45°-45°-90° from the 2" x 8" stock. Two cuts produce two brackets. Near the top of the bleachers where the roof meets the foundation there is a fourth shelf cut and fitted between the diagonal supports of the bleachers. This holds small 3-inch pots with headroom for about 6 inches of growth.

On the end of the Sunpit under the hatch I built a small potting bench, attached on the left to the front bench, supported on the right by another cedar post and nailed at the back to the concrete foundation with four inch nails. This useful little bench is about 2.5 feet wide, 2 feet deep and rises in the back about a foot. It is constructed of 1-inch plywood. Having sides, this bench serves very well to hold a quantity of potting soil at the back available for quick potting of rooted cuttings or for repotting. It is also a good work surface for starting seeds. Above the bench there is a shelf usually reserved for plants on their way to the house. Underneath is a small storage area for flats, glass plates, labels and other miscellaneous supplies.

Electricity in the Sunpit

Successful management of a Sunpit does not absolutely require the use of electricity. As a precaution, however, provisions were made for both supplementary light and heat. Fluorescent lights were installed the full length of the Sunpit about 2 feet from the ridge. Each fixture is four feet long and all are operated by a switch near the door. I use the top of these fixtures as a shelf for seed-flats once the seeds have germinated. On dull days when the panels are not removed from the front of the Sunpit, the lights are turned on. Also, occasionally during the period of our shortest days, the lights are switched on for a few hours in the late afternoon. In a sunpit without electricity, plant growth would necessarily be slowed down in sunless spells, but the plants could nevertheless be carried over until the brighter, longer days arrive. Some sort of lighting makes evening work possible in the pit, a most pleasant activity, especially in the dead of winter.

Because we did not know how well our Sunpit would perform during the many sub-zero nights of the central New Brunswick winter, we installed a small blown-air electrical space heater on the floor of the north side. It is controlled by an inexpensive but adequately sensitive thermostat set for 40°F. It comes on periodically during days of cold, overcast weather, but with the insulating panels left on and with the heavy insulation throughout the Sunpit, it takes very little supplementary heat to bring the temperature up. In fact, although the heater was unhooked inadvertently on more than one occasion when the outside temperature fell to -20°F, the max/min recording thermometer showed a low of 35°F and there was no damage to any of the plants. There is every reason to believe, therefore, that careful management will prevent a freezeup in the Sunpit greenhouse without the use of electrical power.

The fixtures for heating and lighting are wired into an electrical control box near the spot where the cable comes in from the cellar. The thermostat is located there along with several electrical outlets. I use other small electrical devices for special purposes, such as warming pad to provide bottom heat in a germination chamber, a small fluorescent fixture to provide light for tender seedlings, and a small fan for providing extra ventilation if the pit gets too hot in the spring. These specialty appliances could be dispensed with, although the range of cultural operations might be somewhat less extensive than mine as a result. In any event, none of these devices takes a large amount of electricity, and the total cost for running the electrical apparatus in the pit is less than we have spent in our indoor plant room in previous years. The effective use and conservation of solar energy makes the Sunpit far cheaper to maintain than a conventional greenhouse.

Sunpit Management

In the morning the Sunpit panels are taken off the plastic front as soon as the sun begins to lend its warmth. During our New Brunswick winter this is about 9 a.m. By about 10 or 11 a.m. the door must be opened widely for ventilation and by March the hatch must be opened by noon. This must be watched carefully or the temperature can quickly mount into the 90°'s (F.), a condition that would lead to undesirable soft growth. With proper temperature control, the cool moist atmosphere in the Sunpit eliminates some of the typical problems of indoor gardening. The plants do not become "leggy" or straggly-stemmed even though the insulating panels may cover the plastic for one or more stormy days. Furthermore, pest damage is minimal because most of the greenhouse plant pests prefer a hotter and drier environment. Should mould present a problem, a garlic solution used in a sprayer is helpful. Over-crowding of the plants should be rigorously avoided and all dead material should be placed in a small compost area.

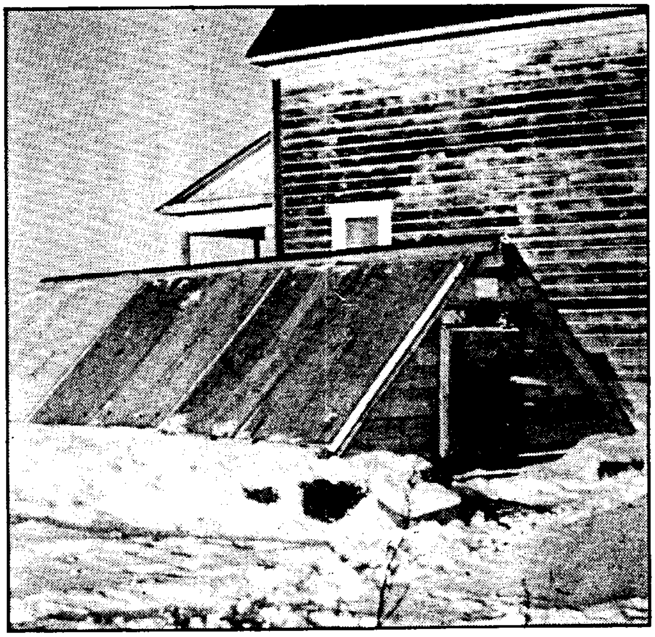
By late spring when the Sunpit is bursting with flats of transplanted seedlings, many of the semi-hardy plants and maturing bulbs can be moved to cold-frames. And when the transplants have been put into the garden after the last spring frost, the Sunpit takes a well-deserved rest. It is not practical to use it during the summer because it would be very difficult to keep it cool enough and also provide enough light for healthy plant growth.

Cost

We whittled the cash outlay to a minimum by using local and recycled materials, by furnishing our own labor, by solving problems with ingenuity rather than hardware and by not rushing the job. We spent roughly $350 on such items as delivery of sand, cement, mixer rental, unplaned lumber, asphalt shingles, plastic sheeting, styrofoam and plywood.

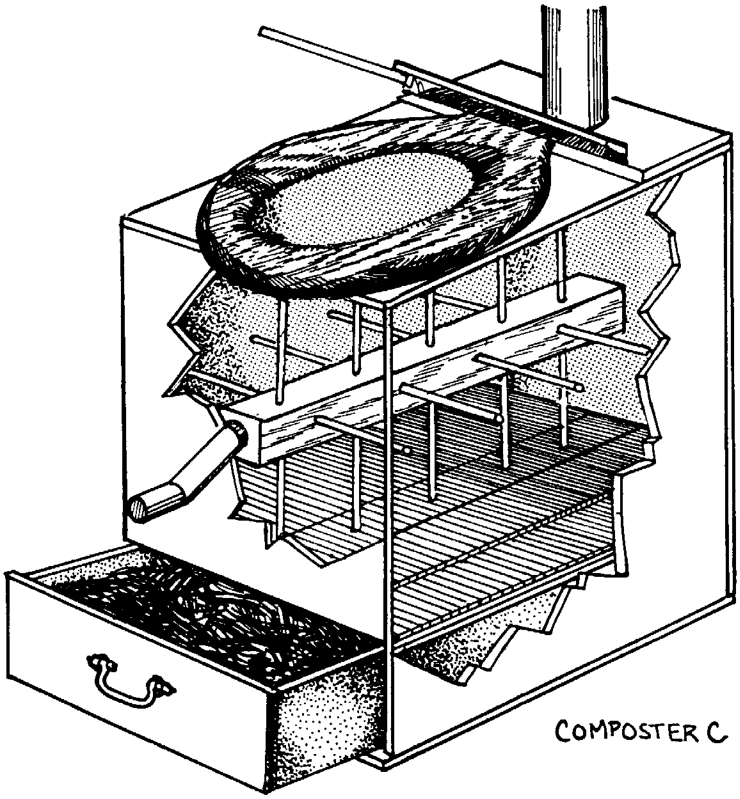
Bibliography

Much of my inspiration and Sunpit planning came from the book, **Winter Flowers in Greenhouse and Sunheated Pit**, by Kathryn S. Taylor and Edith W. Gregg. It is published by Charles Scribner's Sons, New York and I believe the revised edition (1969) is still in print. This is presently the Sunpit enthusiast's bible. Kathryn Taylor also published an article on **Cold Pit Gardening** in Horticulture Magazine, autumn, 1974. Ken Kern, Sierra Route, Oakhurst, CA 93644 has also written about the Pit Greenhouse, chapter 9 in his **The Owner-built Homestead**, Kern's ideas are not entirely practical for north temperate pit greenhouses which must be dug deep into the ground and covered with insulating panels at night. He does provide a good plan for a half-dome Sunpit which could be attached to an existing structure and could actually provide some of the dwelling's heat, if carefully managed. For information on the plants suitable for the Sunpit, Kathryn Taylor's book can be supplemented by G. W. Robinson's **The Cool Greenhouse** (Penguin Books, 1959), out of print, unfortunately, but perhaps available through a library.



Indoor Composter Toilets

by John Shore



People often wonder how we can go on growing food without putting something back on the land in return. Sure, the solar energy, gases and water needed for plant growth are freely available, but what about mineral trace elements and the humus needed for a good soil structure? If we don't want to find ourselves starving one sunny day, we must make sure that everything we take from the land is returned, and in a form suited to the cycle of decay, uptake, growth, harvest, use and decay once more.

Aerobic composting is one of the most natural ways of converting faeces, urine, plants and organic materials into safe fertilizer. The system is simple, inexpensive to build, uses no water for flushing and is suitable for use on a domestic scale. As with any natural system, many variations are possible, and these toilets are still experimental. Because of widespread ignorance of the role of nature in our lives, fear and prejudice are common attitudes and your local authority may not approve such a system.

Safety

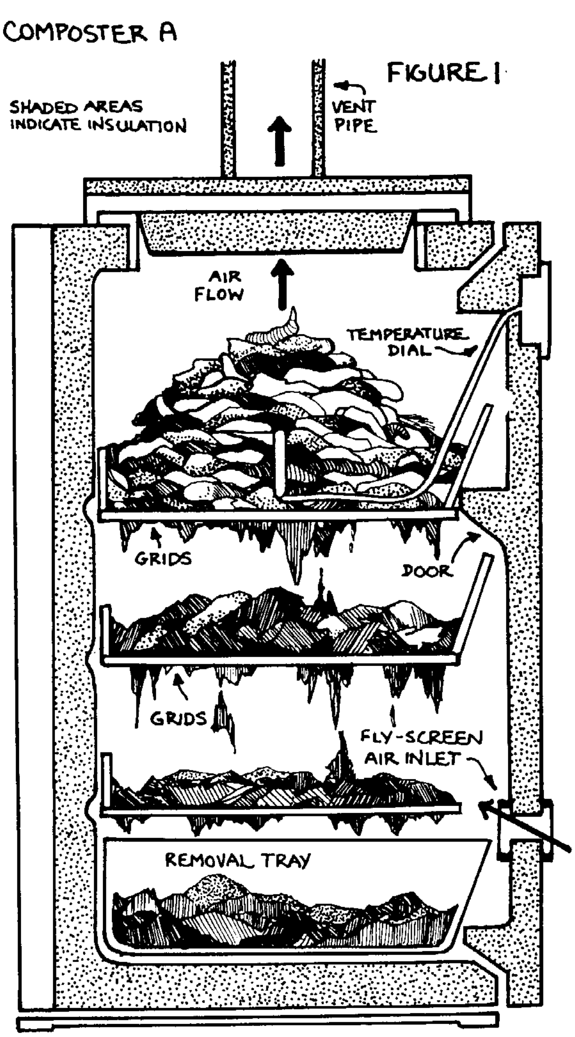
Human and animal faeces and sometimes urine, contain organisms which could harm your health if reasonable precautions are not always taken. No system is perfectly safe, water closets do not prevent contamination of hands. Faeces and diseases are natural to our bodies; we all have to live with them both.

Construction

The toilet must contain the compost safely and provide optimum conditions for decomposition. You will need an insulated container which must be water and air tight. An air inlet and outlet, both screened to keep out flies must be provided for ventilation. Use the finest screen you can get, because some flies are tiny!

The outlet pipe must be insulated and provided with a cap to keep out rainwater. The cross-sectional area of the outlet must be larger than that of the inlet.

You may be able to find a ready-made container. I've been converting a scrapped refrigerator into a toilet. Take care you don't get an eyeful of harmful chemical when you cut away the pipes. You'll need to cut a hole in the top and make an air-tight lid, fit an air vent in the door and an outlet pipe. The shaped panel on the inside of the door can be replaced by a flat plastic sheet. The large door gives a good view of the interior. Inside you will need a number of grids to support the compost. If these are made with wood or metal sides they can be arranged to keep compost and liquids away from the sides of the composter, so that they can only fall into the tray that must be made to collect the finished compost. The grids can be 3/4" (20mm) tube spaced at 3" (80mm) centres. The main problems with fridge conversions are sealing the insulation against moisture penetration and ensuring that liquids flow into the tray, and do not seep out under the door (see Fig. 1). Two of my experimental units have been made from 1/2" (12mm) chipboard, with internal coatings of Bituminous and waterproof paint (the rubber-based paints supplied for roofing or water tanks are ideal). Marine grade plywood will be better than chipboard (which is still going strong after two years), but do use waterproof glue.



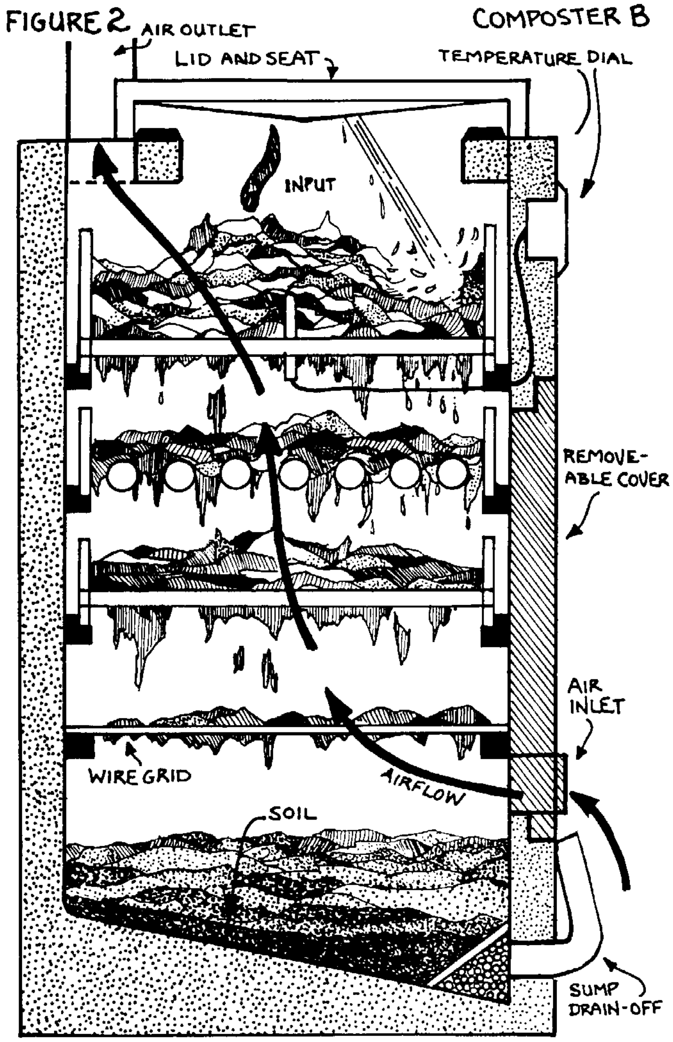


Fig. 2 shows a simple toilet which was built of chipboard, and insulated with 1" (25mm) expanded polystyrene sheet. It is 49" (1200mm) tall and 20" (500mm) square, fitted with grids like the fridge has. Before first using the toilet cabbage leaves are laid out on the grids to stop the compost falling through. A layer of soil is placed in the bottom of the toilet to absorb excess moisture.

Another unit has been built incorporating a stirring arm. (Figs. 3 and 4), but is rather complicated to build. It is made of wood and lined internally with 1" (25mm) expanded polystyrene, glued in place.

The stirring arm is turned each time the toilet is used, helping to mix and aerate the compost. A grid of tubes are placed in a curve just below the sweep of the arms. The stir arm is made of 2" x 2" (50 x 50mm) wood and 5/8" (15mm) dowels. Where the arm rotates in the sides of the composter; sleeves, cut from 2-1/8" (55 mm) PVC pipe are fitted to act as bearings. Discs fitted to the stir arm locate it within the toilet and help prevent leakage. The top of the toilet is removable and a deflector of flexible plastic/rubber is fitted below the seat to top urine reaching the front wall. The compost gradually falls through the tubes into the lower grid and eventually into the bottom compartment. The finished compost is scooped out after the cover, which also forms the step, as has been lifted off.

Small toilets like these will be suitable for regular use by one or two people. However, all the urine can not be added at the start, since there will not be sufficient compost to absorb it. The same situation might arise during a party. Fortunately urine is rich in nitrogen and makes a good compost heap activator or can be used direct as a liquid fertilizer. Therefore a separate collection of urine will sometimes be needed. (See the urinal on page 23 of **Cloudburst 1**.)

Figure 5 shows composter D, which is an improved version of composter B (Fig. 2). Since the unit is four feet high, a small staircase will be needed. Figure 6 shows a three-step unit. While this will enable you to use the toilet without much effort, it increases the area of floor covered by the toilet to 57 x 22 inches.

Figure 7 shows how to cut the components from an 8 x 4 foot and a 4 x 4 foot piece of ½ inch thick board. Ensure that the edges of each component are planed flat before gluing and pinning together. The cutaway drawing (Fig. 5) is fairly accurate in terms of dimensions. Think carefully about the design, the materials you can use, and the job they will have to do. If you can improve the design, that's good. Pay particular attention to the waterproofing, especially around the openings for the toilet seat and ventilation pipe. A good seal is also needed where the grid-supports are attached to

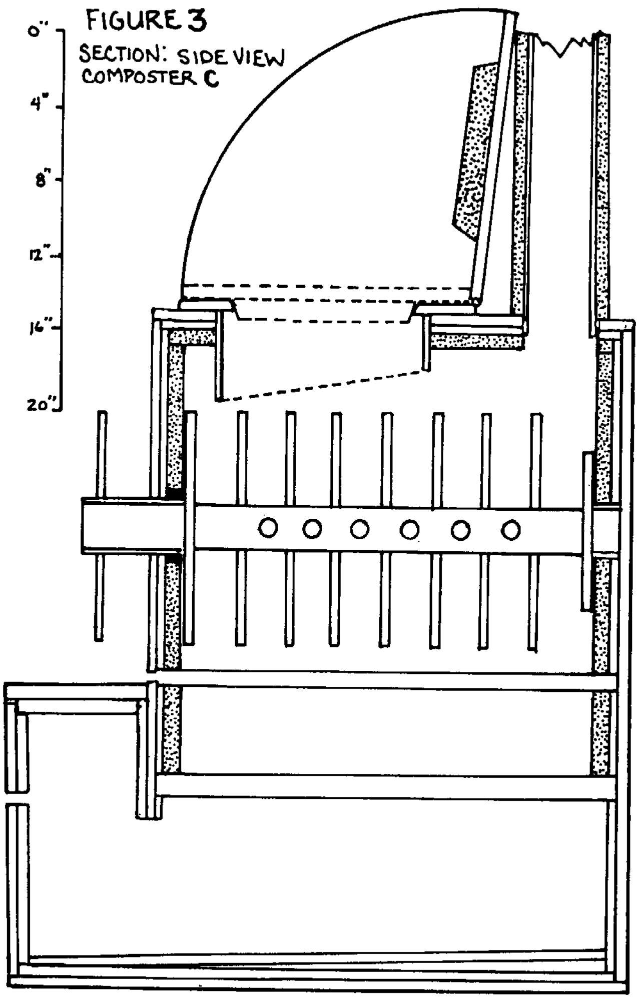


FIGURE 3
SECTION: SIDE VIEW
COMPOSTER C

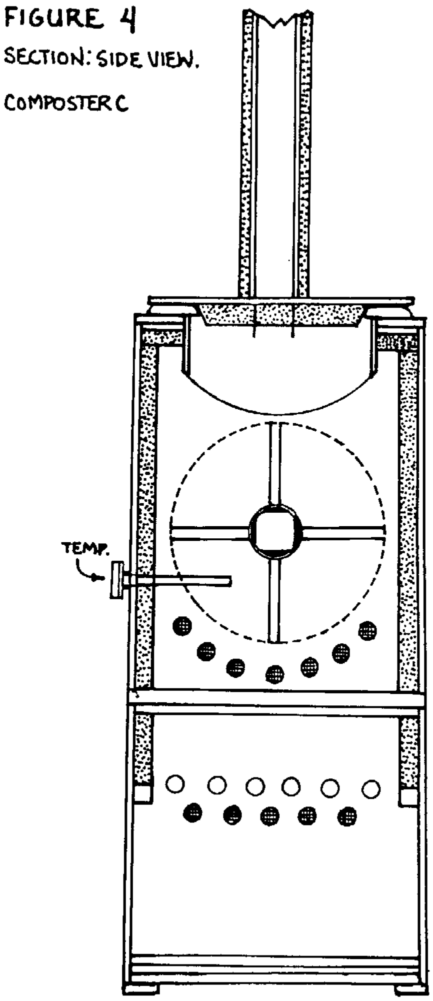


FIGURE 4
SECTION: SIDE VIEW.
COMPOSTER C

the walls and water may accumulate. The top of the toilet and the lid over the finished compost can be lifted off for access. Use a soft plastic or foam strip to keep these joints airtight. Externally the unit can be finished with panels of insulation.

Figure 5 shows the air flow through the toilet. Air entering through the screened inlet can flow through three apertures, which lead to three plastic channels (two-inch square drainpipe cut in half will make fine channels), bolted to the inside front of the toilet. Two inch by ½ inch slots cut in the sides of the channels allow air to escape and circulate underneath the grids. The slots are placed close to the wall, just beneath the grid-supports, so that compost cannot block them up. One channel is longer than the others and allows air into the upper part of the toilet. The lower ends of the channels are blocked off, so that compost cannot force its way up. The grids shown in figure 5 are made from metal or strong plastic angle.

Some people don't seem to care about pathogen survival – they are quite happy to either dig faeces straight into their gardens, or compost it on the garden heap. One simple way of "cooking" the compost before you take it out of the toilet (if you have access to an electricity supply) is to put a very carefully insulated heater element in the toilet, say just under the three air channels in the composter(Fig. 5). A soil-warming cable would be quite good. Then you could switch on and off whenever you wanted, perhaps just to cook the compost before use, or perhaps only on nights in winter. The cable could also be timeswitch controlled.

Composting

Ventilation of the toilet has to remove odours, water vapour and provide oxygen for aerobic decomposition. The compost must be kept warm and moist, but not too wet, or pore spaces block and anaerobic conditions occur. If too dry, crusts will form, limiting aeration and microbial activity Decomposition is slow at low temperatures.

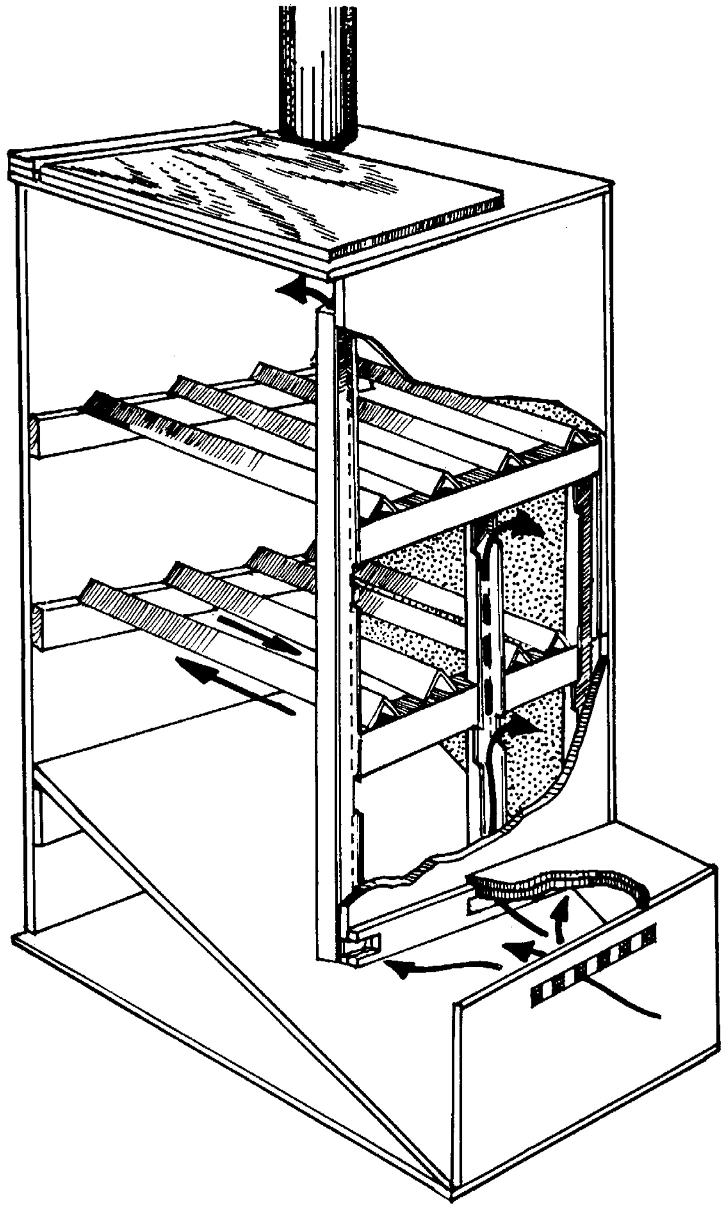
Micro-organisms (bacteria, fungi and moulds) feed on the materials, transforming them through molecular changes into nutrients suitable for uptake by plant roots. Because living organisms use about 30 parts of carbon to each unit of nitrogen, the amount of carbon to nitrogen (C/N ratio) in the materials change during the process. The carbon is metabolised for energy and the nitrogen is conserved as tissue. By this process materials with high C/N ratios (straw 128:1; potato tops 25:1; grass cuttings 19:1) can be reduced to the 10:1 favoured by plant roots. Plant and organic materials compost best if they have been finely shredded to increase surface area and help mixing. I strongly recommend doing this.

Bacteria such as E.coli are normal inhabitants of the gut or large intestine, but can be harmful given access to other parts of the body. Diseases like typhoid, intestinal worms and the much more common Salmonella food poisoning organism must be destroyed during the composting process. These organisms can be killed by heat coagulation of their proteins or by hostile environmental conditions and bacteriophages. The first method is very quick (E.coli die within 1 hour at 55°C) but the second may take 12 months. Since we are not heating the compost artificially we must retain the compost for at least a year. Weed seeds can be destroyed either by premature germination or by protein coagulation (40-60°C).

The analysis of compost from my first toilet showed a C/N ratio of 9.1:1; 1.82% Nitrogen, 3.94% Phosphate and 1.73% Potash. Compared with other available compost-products this has a very high phosphorus and potash and an average nitrogen content.

These are only suggestions for building experimental units. If you are not able to build a strong, water-tight toilet and look after it carefully, play safe and don't try. The process and the toilets are described in greater detail in my handbook, **Aerobic Composter Recycling Toilets.** If you want more information write to me: 23 Park Street, Taunton, Somerset, England.

FIGURE 5
COMPOSTER D



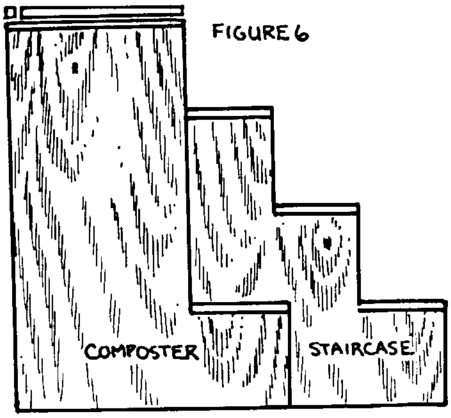
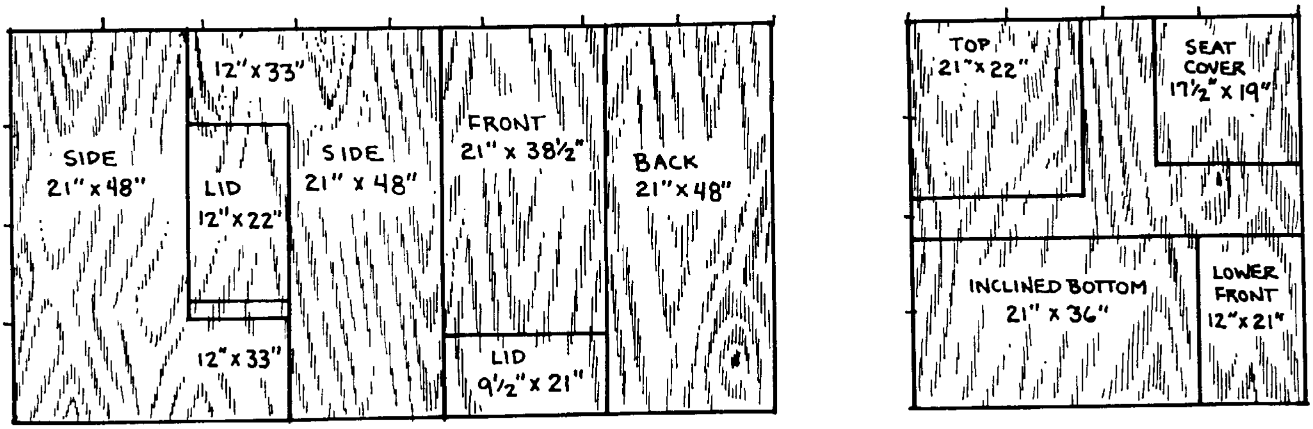


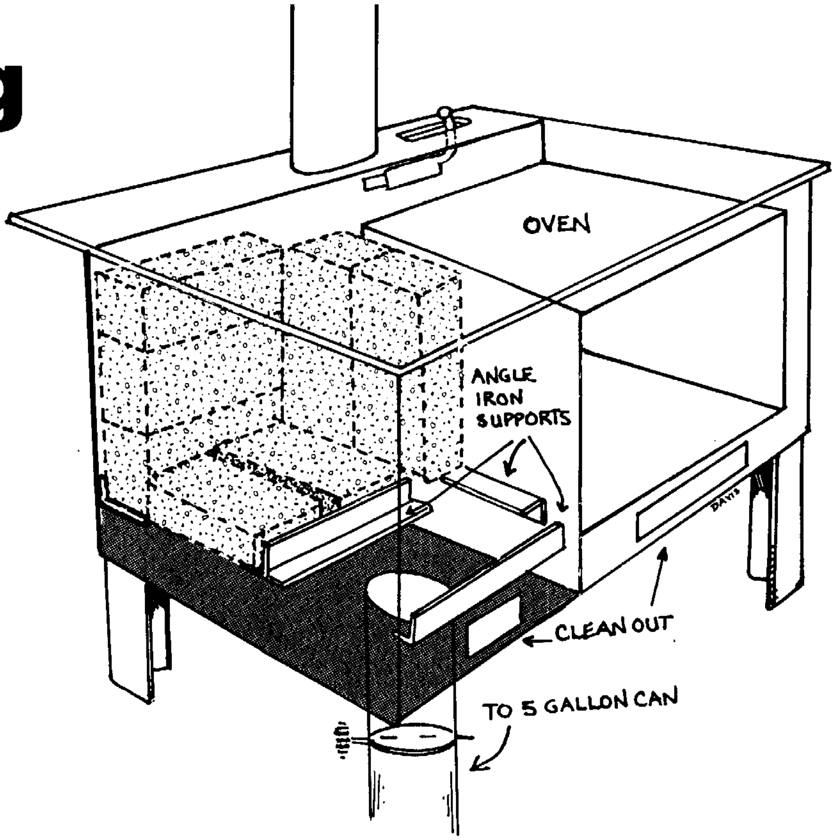
FIGURE 6

FIGURE 7
CUTTING PATTERN; DIMENSIONS IN INCHES.



Revitalizing Wood Ranges

by Kurt Boyer



For those who can't afford a new stove ($400-600), here's a method I found successful for re-vitalizing an old one, with burnt out grates, etc.

Most old stoves are usually burnt out in the grates and the cast iron pieces which protect the oven from direct heat of the firebox. We have an old Fawcett stove in which one grate was shot and part of the oven protector was also burnt out. (Many were the cookies burnt on one side and raw on the other.)

I removed the grates and all the supporting iron as well as the oven protectors. Because I wanted a large firebox, I decided to use most of the ash pan space as well. In the bottom, upon which the ash pan used to sit, I cut a 6" hole and through this passed a 6" stovepipe which went through the floor and into the top of a 5 gallon drum under the house. This formed my draft and ashpan. In the pipe I made a tight fitting butterfly valve (like in a carburetor on an automobile) with which the draft can be regulated.

The draft pipe extens outside for two reasons. First is that if a fire burns air from inside the house this air must be replaced and the only way it's going to come into the house is through cracks around windows and doors. This sets up unpleasant drafts within the house. With the pipe coming directly into the firebox, the fire burns this air only. Secondly, this setup makes it easier to clean the ashpan outside rather than walking through the kitchen with a bunch of dusty ashes.

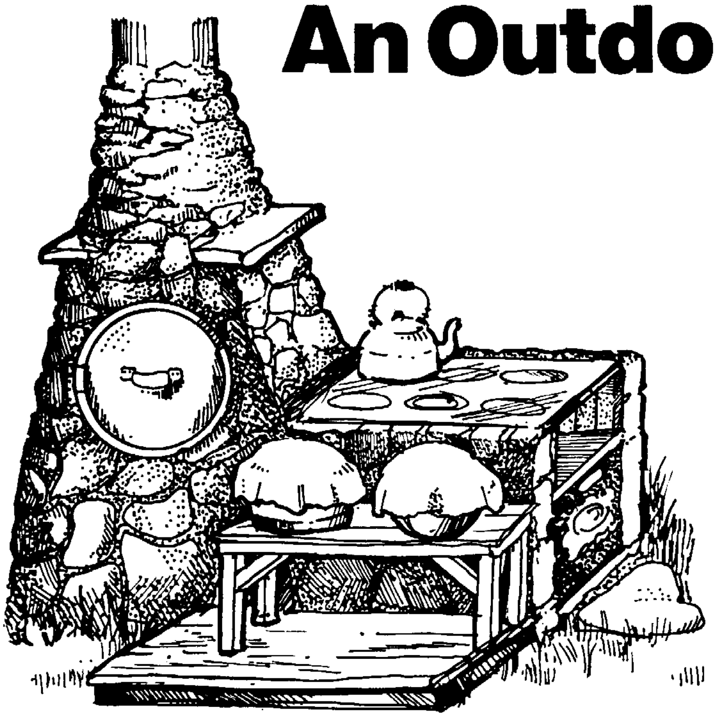
The next step was to weld some angle iron supports about 4" off the bottom of the ash pan floor. Upon these supports I placed firebricks (of the type used for fire places) with about 3/8 to 1/2 inch spaces between them to let the air up to the fire. (One could also take a masonary drill and put many holes in the bricks.) These took the place of grates.

Then I lined the interior of the firebox with more firebrick. Finally I mixed up a "mud" of ½ silica sand and ½ fire clay and used this to plug up the old draft on the side of the stove and all other holes and cracks between metal and bricks.

This firebox loses very little heat and burns with a lot of blue flame, emits very little smoke (smokes only when lighting up or if closed down completely with wet wood) and gives a very hot fire to the top surface. Also the brick now protecting the oven, insulates just to the right amount giving an even temperature throughout the oven. It will also hold fire for 4 hours or so if closed down.

A small hole (should have a cover) below the "grate" bricks allows the ashes to be scraped into the draft pipe and thus to the 5 gallon ashpan (which only needs changing every 2-3 weeks in the winter when using the stove 12 hours/day.)

I think if someone wanted to, they could build a stone or tile cookstove (tile would clean easier) with a brick lining. The simplest method would be to use a surface from an old cookstove and make the rest of brick and tile. A stove pipe oven would simplify matters greatly.



An Outdoor Rock Stove

by Richard Eichenauer

In the summer we spend most of our time outdoors and find it especially convenient to do all cooking, baking, laundering and canning outside the house. The house not only remains cool that way but we are also in fresh air and don't have to be quite so pedantic with water we spill, cherry pits we spit and wood chips that fly. For this we needed an efficient outdoor fire arrangement. Some people put an old kitchen range out and use it until it rusts out. We came up with the rock stove described in the following pages. It is practically built with waste materials, cement and firebrick excepted, although some items may have to be bought from a junk dealer by others. But I would say that in no way would the cash outlay exceed $70 and will probably be as little as $30, while any old stove these days costs at least three times that much and won't do half the job this one will.

I will describe the stove I built and give alternative solutions for parts that may be found in your dump and junk yard. Take all measurements and methods as approximations and keep in mind that you want to build your own stove and not mine. My present one can stand some improvements and they have been considered in the text.

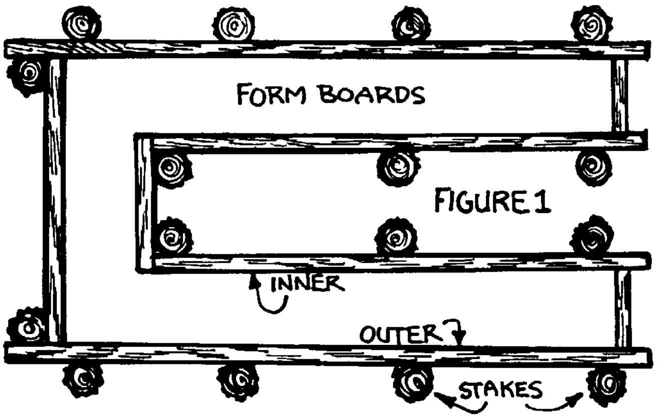
List of Materials:

1. Pile of rocks, angular rather than rounded, and granite or similar hard, sound rock rather than shale.
2. Pile of sifted sand without much silt or other organic materials.
3. Depending on the size of your stove and chimney, and assuming free form construction, about 4 to 6 bags of Portland Cement, type I.
4. Two bags of lime to be mixed into the mortar as needed where you want the mortar more sticky, but go sparingly on it, it weakens your mortar and makes it only stickier to glue the rocks together without much weeping of joints. I don't think much of the ready bag-mixed "Masonry Cement". Portland Cement is far stronger for the purpose. Any surplus lime can go into your compost heap.
5. Twenty firebricks of the 4½" x 9" x 2" size – unless you have really sound rock like basalt.
6. 2' x 4' piece of steel plate ¼" thick or similar for the fire grate. Several other scrap pieces of heavy gauge steel can be used instead, if one solid piece is unavailable.
7. Stove top from an old kitchen range with removable round insert plates. This too can be a solid piece of steel plate, as pots should never be exposed to open fire – they will stay cleaner that way.
8. A few pieces of 2" or 3" angle iron or old leaf springs about 30" long for the rock support of smoke stack above the firebox.
9. Old water tank or 10, 13 or so gallon oil drum for an oven drum. The drum should be at least 2' long and have a diameter of no less than 14". Water tanks and 13 gallon (tall type) oil drum are just fine.
10. Two old oven doors from wood, gas or electric range (as can be found in every dump) for ashpit and firebox doors.
11. One round home-made oven door with hinge to be attached to the opening of the oven drum. An old big enameled lid or a nice wooden one with a metal inside and some insulation in between will do fine.
12. Optional home-made damper of 3/8" rod and piece of heavy gauge sheet metal, like an old lawn mower blade.
13. About five to ten 5 gallon old oil buckets (from any dump, garage or logging work shop) or similar cans to be used as smoke stack inside the chimney. Commercial flue lining can be used too – but will cost a lot of money.

14. One or two square feet of ½" hardware cloth to be used as a spark screen at top of chimney opening.

Materials for the building form if one is being used:

A pile of 4 to 7 or 8 feet long 1" boards, about 12 to 20 stakes about 6' long (scrap 2" x 4" can of course be used), about 1 pound of shake or box nails 2½" long and some old wire for ties (Fig. 1).



Building Details

Footing and Base: As in Fig. 1, a U-shaped trench about 1½' deep (depending on your ground frost depth) is dug wide enough to accommodate the form for the footing of the walls of about 9" to 12" thickness. If dug into clay, no form for the footing is needed, but the stakes for a form for the walls above ground can be pounded into the ground beside the footing when it is just up and above ground level.

The stove can be built without a form, but I prefered a form to keep the whole structure in line and hold fresh mortar in place. I also like a form to give a structure like this an even shaping and taper, usually concave, broader at the base and narrower towards the top. That makes for stability and eliminates totally the worry about plumbness.

The form can be built quite flimsy and improvised since the rocks lean only lightly against it. This is not a high-pressure commercial "bulge and bust" poured-concrete form. Not all boards (and definitely not each point with a backing stake) have to be nailed, only where the nail is needed to hold the board in place and up. The rocks will press the boards lightly against the stakes and keep them there. This will make it much easier later when the form gets removed, particularly the inside form. Tie wires or short nailed tie boards I use only above the wall. No ties go through the wall or will be incorporated in the rock and mortar – though that could be done. Stakes could also be braced from the outside with another set of stakes pounded slant-wise into the ground, but this kind of thing gets in the way when dancing around it with heavy rocks in one's hands. I usually combine a couple of methods, improvise and wiggle my way through.

As I lay rocks and mortar upon the footing I insert always one more board on all sides as one round of rock is completed. That way a high initial form structure doesn't get into the way of rocks and fingers; needless to say, the heaviest rocks go on the bottom courses. Build this U-shaped base up to a height of about 18" and then remove the inner form, boards and stakes and place the ashpit floor slab into the centre of the U, curving the floor up at the closed end like in drawing cross-section A. That will make it easier to remove ashes later on. At the open end we can now incorporate a hinge provision for the ashpit door into the soft cement. An old oven door has at the bottom hinge pins to the sides that I inserted into the side walls at the beginning of the wall building, leaving a little gap in the form boards at that point. That was the easiest, but a piece of sheet metal or other suitable door on simple strap hinges will do too. Just insert the strap hinges into the soft cement slab. I made a weak mix concrete batch for that slab with a fairly smooth surface. Ash removal is easier on a flat surface with a square shovel than on uneven rocks, but a rock floor will do also.

Firegrate: We are now at an 18" level all around the U and can lay the firegrate into a bed of mortar on top of the open end of the U walls. Whatever pieces of scrap metal are being used, it suffices to have them supported by about 2" on either side of the wall. Too deep a penetration into the rocks might crack them apart through buckling and expansion during heat. My grate is a solid ¼" steel plate, 2' by 4', scrap from a logging repair shop, without any holes or slats for air intake from below or for ashes to fall through. Our air comes from the front opening, where until now I have not installed a door. We burn a lot of scrap wood from old structures and the woods. They are often oversize pieces and stick out the firebox, being supported at the other end by a nearby bench. We all hop and dance about it with pots of hot stew in our hands. Ashes are shoved to the rear where there is a big gap between the grate and flue down to the ashpit, where they collect until the garden or the compost heap are ready to receive them. There is lots of space underneath the grate for the ashes.

If you make the grate out of several smaller pieces of heavy gauge steel, the gaps between them will provide an air intake if you close the front opening of the firebox with a tight fitting door. You then provide some air holes in the bottom door of the ashpit – just like a regular kitchen range is built. For an outside stove like this, the leakiness of the door fittings are usually enough for air to get in.

Firebox: Now a collapsible box can be made, about 18" to 20" wide and about 30" to 48" long, depending on the size of stove top you have managed to scrounge and on the size of your fire grate. This box is set onto the grate and takes for the time being the space of the future firebox. And between this box and the outside form boards, we have again our form to go on with the rock laying. But on the inside of the wall, we now place the 10 firebricks (or so) on either side, and fill with mortar and rock the remaining 6" to 8" behind them. I placed my bricks right tight to each other without mortar between the bricks themselves. I also used the 1" thin bricks and a couple show cracks, but they are standing up fine, after seven years of hard use. I recommend now 2" thick brick. (This kind of lining can always be replaced after 20 or so years, if necessary.) The mortar around the firebox can be improved through the addition of fire clay, which I did not have and did not do.

If you have very sound rock, that will not shatter in a hot fire, you can use it instead of firebrick. Basalt supposedly is such a stone, a dull black beautiful stone of volcanic origin, but very rare in our area. The advantage of the brick lining is, that if it really wears away someday, it is just those 2" and the lining can be replaced, while rocks usually would penetrate deep into the wall and the whole wall section would have to be done over again.

Oven Column: An easy collapsible box on stilts can now be set between the grate and the enclosed inside U cavern. It again makes with the outside form the space into which rocks and mortar can be laid up towards the point where the drum is going to rest. Such forms can be quite improvised and escape words totally, since you are building in curves and slants and tapers, but unless you have imagination you won't tackle this kind of thing anyway. Just make sure that you remain with about 3" to 4" of open space around the oven drum, when it is set in place; that means drum diameter plus 8" is the lower inside of your smoke stack.

Stovetop: We are now at about a 27" level off the ground all around and are ready to install a bunch of metal items.

Above the grate area goes, again on a nice mortar bed, the stove top from an old kitchen range. Ours is a 32" by 24" cast iron one with four 9" and two 8" holes with removable plates. A special feature on this one is that all crosspieces and bridges, that hold the round plates in place, are also removable and so the whole stove top (except the basic rim) can be removed and the fire openly enjoyed. This has given us many an evening with guitars and drums, kettles and pots giving slowly away to open flames and smoke chasing the mosquitoes. Search a little and you may be just as lucky.

If you can't find an old stove top at all, a solid piece of steel plate will do too. It will have the advantage that the pots and pans will not be exposed to the open fire and so will stay much cleaner, although a frypan or waffle iron will take a little longer to heat up.

This stove top is either going to be the very top of the stove at this point or it can have a shoulder of about 4" on either side, the coping of the rockwall. If you make a shoulder, provide a V-groove between it and the metalplate, so that the coping won't get disjointed when the metal expands. We have the V-groove and the shoulder, and support on it big canning pots and laundry tubs when some of the stove top is still taken up by kettles and stew pots. This is a great advantage instead of lifting heavy and hot boilers off and on.

Rock Support: Next to the stove top goes the rock support, a few pieces of heavy metal about 30" long, that will support the rock above the fire box where it will form the smoke stack. I used a wornout chainsaw bar and an old leaf spring. The chainsaw bar got soft in the heat and is now drooping in a half-elliptical shape down into the firebox, without doing any harm, in fact prventing sticks of fire wood being shoved down into the ashpit. The spring is standing up fine. So either old leaf springs or some length of heavy gauge 2" or 3" angle iron will do. These pieces sit in mortar right next to the stove top and lay about 3" to 5" into the rock walls on either side, having firebrick on the inside underneath.

Oven Drum: Our oven drum sits about at the height of the firebox with flames drawing right against the metal. This seems a mistake, for it heats the oven unevenly and one has to watch and tend the fire carefully to get satisfactory results with breads etc. We think now the oven drum should be higher in the smoke stack at about chest height. That will circulate the heat evenly around the drum and the oven can be tended without stooping. Also the need for a damper will probably be eliminated.

Our drum is an old cut-off water heating tank of 14" diameter and about 30" long. We feel that is about minimum size of diameter. Old heavy gauge oil drums of between 10 and 20 gallons will do the job too. There are the 13 imp. gallon tall type oil drums that seem just about ideal for the job; although they're not that heavy a gauge sheet metal, they are of heavier gauge than most commercially fabricated stoves and will last at least as long, especially since they are not directly exposed to very hot flames.

Old oil drums may need a bolt or two at the closed side with it suspended into the rock wall, as the old oven drums from the Hudson's Bay Company used to be, while water tanks come quite long and can be laid right into the wall for about 2" depth. Although they don't pick up much heat in the rocks, the shorter suspended oil drums will be exposed with their back to the hot flue air and smoke.

Whatever drum you use, set it about 4' or about chest height above the firebox, back into the wall or suspended on one or two bolts (one bolt in the exact centre makes them quite easily removable and they can be cleaned or exchanged when rusted out). At the open end extend it right through the rock wall so that it forms the oven opening to which a home-made door can be hinged. The door can be made of a big old enameled lid like the ones that come from leaky old blue canners with a handle attached. But even a wooden round with a metal inside will do the job.

Wherever the drum is surrounded by mortar and rock, wrap around the drum before installation a length of 2" thick fibreglass. It will compact as rock and mortar is packed around it, but will leave a big enough flexible and chinked crack for heat expansion of the drum. This crack will also make the removal or exchange of the drum later on easier. If fibreglass is not available, simple clay, fire clay or rockwool will do. The clay may need chinking anew now and then, but will not cause much smoke leakage.

As you now lay rocks and mortar up and around the drum, be sure to leave at least 2" to 4" of space between the drum and the rocks (or your ingenious little removable form) where the smoke can draw through. Our space is about 3" to 4" wide and can be cleaned with a length of chain on a rope being moved up and down from above the chimney. Always make sure you clean both sides when you do! If your space is below 2", you may do well to have your drum removable for cleaning – as those Hudson's Bay oven drums are built.

About halfway up the drum, I placed a damper on the stove top side of the drum, which when closed, will send most of the smoke around the drum to the other side. I believe with a higher drum position this damper is not needed, unless you build very tight openings and insert two dampers or one big one higher up, which will give you a very controllable fire.

We laid rocks and mortar up above the oven drum for at least ½' on all sides. This brings us at a 5½' to 6' level to a kind of platform with a roughly square hole in the middle. That finishes the lower part of the stove. Whatever pieces of form you have now still inside the stove or smoke stack, take them out – the cleverer you built your form, the easier it will be. But if something remains inside, don't worry – the first few slow fires will char and burn the wood a bit and they will fall out into the ashpit, as pieces or as ashes. Just be sure to have no wood incorporated or penetrating into the rockwall as that would later weaken the structure.

Smoke Stack and Chimney: Over top of this hole in the platform goes the chimney. I placed 5 gallon oil cans over top of each other and built with rocks around them. The cans fit just a little inside each other, being a bit tapered, and are of heavier gauge than regular smoke pipe with about a 11" diameter. Other similar cans, clay tile or regular flue lining can of course be used too. The expansion from heating has caused through seven years of hard use only a few hairline cracks. If one is worried, the cans could be cut open and lapped with their sides, which then would allow them to slide a little past each other.

One could now build an outer form, but at this point I gave up on forms and laid rocks around the cans in a rather free way, interlacing now and then with strips of cut chickenwire doubled-up for reinforcement against cracking or loosening rock sections. A lot of old chimneys are by no means a monolithic block, but an interlocking mass of stone or brick sections, standing up even if the whole house is being put on a flat bed and moved to a different location – as I have experienced myself.

This rock laying can be done with imaginative carefulness, letting some rocks project out to form little shelves onto which thermometers, rennet starter solutions and tooth brushes can be put, or a cup of tea kept warm.

The chimney should go at least 9' high. Ours goes through the roof of the summer kitchen (a roofed over outdoor space) and about 2' over the roof to an overall height of about 11'. It can be topped with a coping of a concrete slab as a weather guard, or some other suitable piece of hardware that won't fly away in a strong wind. A piece of ½" hardware cloth is definitely advisable as a spark screen. Soot and hot sparks catch in it and won't fly into the dry woods (to cause a fire). It now and then needs shaking out to let the smoke through again. Watch the fireworks when burning dry tamarack or cedar. You don't want to do that in "Extreme Fire Hazard" without the spark screen.

After the structure is finished, perhaps some pointing between rocks has to be done, but it is better to do that right when you lay the rocks. Pointing brings structurally no strength, you only fill a crack.

Now: don't start a fire right away. Season the whole thing for at least 5 to 6 weeks with a few buckets of water every day, keeping damp racks and sacks draped over it in the summer time. After that seasoning, let it dry for a while, a week perhaps.

Starting to Use the stove: Your first dozen fires should all be very gentle, rather low and long instead of short and blazing. Some hairline cracks will develop as time goes on but they will not do any harm.

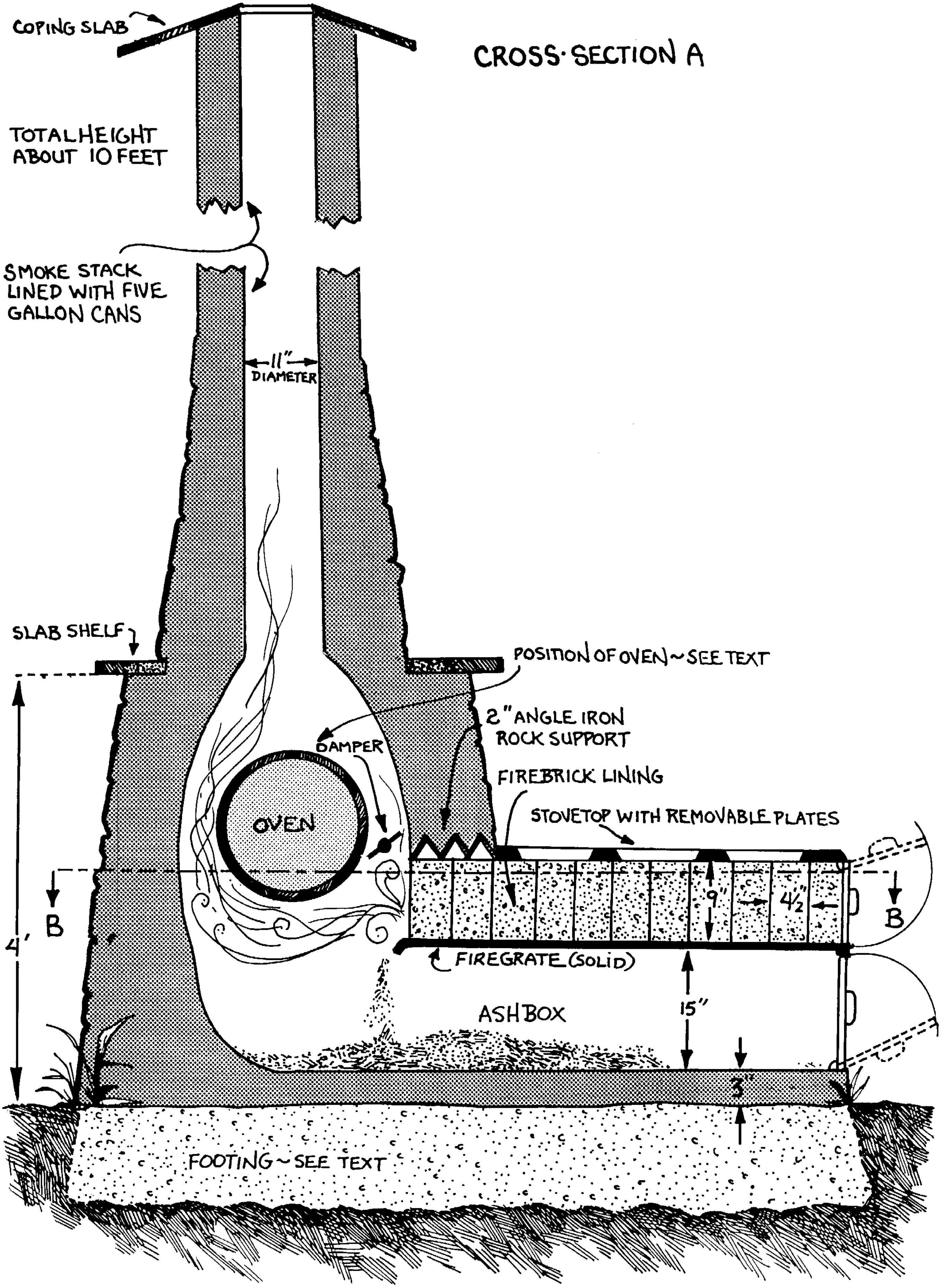
Clean the smoke stack now and then, paying attention to the two sides around the oven drum. When the stove is not in use, wax or grease the stove top against rust in the winter, fall and spring.

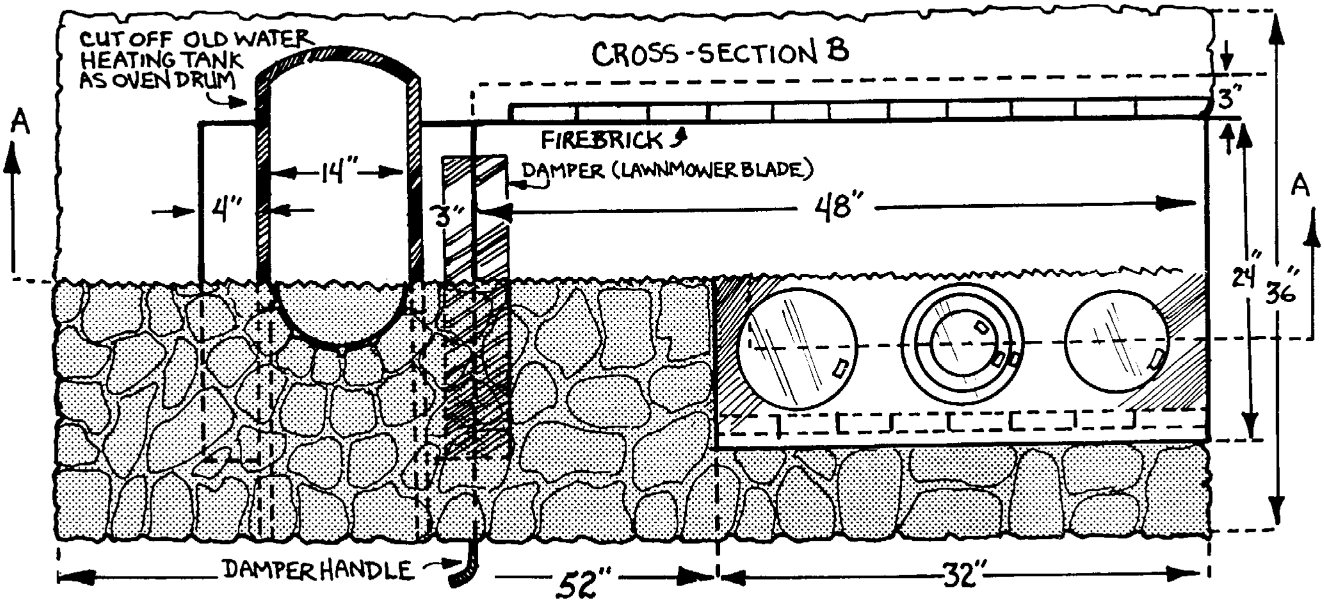
The fire: for just a couple of pots we built it mostly to one side, using the three holes in line to each other; for baking, towards the back; and for canning and laundering, mostly all over and of course any combination. The firebox is after all almost 2' wide and goes in deep; it doesn't have to look like a volcano's mouth all the time and any odd size wood can be used. The person who cuts the firewood will be grateful for this detail.

Afterthoughts: Tony built our first stove of this kind just with rocks and clay and it did ok for three seasons. Then the weather started to take it apart dangerously and I replaced it with the above described version. Building such a stove outdoors gives a person lots of play for experimentation and practising, but to build one like it inside the house would be of even more advantage, since one can combine cooking, baking, heating and warmth storage all in one unit.

We find that all customary cooking stoves have too small a firebox to be efficient for heating, as well as being built too drafty to really control a long sustained fire, while most heaters don't provide enough surface area to cook upon and of course never have an oven. This was made up for years ago by what I referred to earlier as the Hudson's Bay drum oven. This was a contraption of sheet metal, one smaller drum set into one bigger one with about 1" to 2" of air space all around between the two drums. The outer drum had stove pipe stubs, top and bottom, to be set in the stove pipe above a heater. There was a door to close the oven. This was a very functional and effective oven and threw out a lot of heat in addition. But being rather flimsily made, they burned out fast. We went through a bought one and two home-made ones within five years in conjunction with an Ashley heater, on which one can cook pretty well (cheap model).

A home built indoor rock stove can have a good size firebox to be used with unsplit rounds of 3' to 4' length (which saves half the sawing) and so functions as a heater. It can have a fair size stove top for cooking and a built-in oven for baking. In addition to this, one can build into such a massive rock stove additional moderately warm and


COPING SLAB
CROSS·SECTION A
TOTAL HEIGHT ABOUT 10 FEET
SMOKE STACK LINED WITH FIVE GALLON CANS
11" DIAMETER
SLAB SHELF
POSITION OF OVEN ~ SEE TEXT
2" ANGLE IRON ROCK SUPPORT
DAMPER
FIREBRICK LINING
STOVETOP WITH REMOVABLE PLATES
OVEN
9"
4½"
B
B
4'
FIREGRATE (SOLID)
ASHBOX
15"
3"
FOOTING ~ SEE TEXT

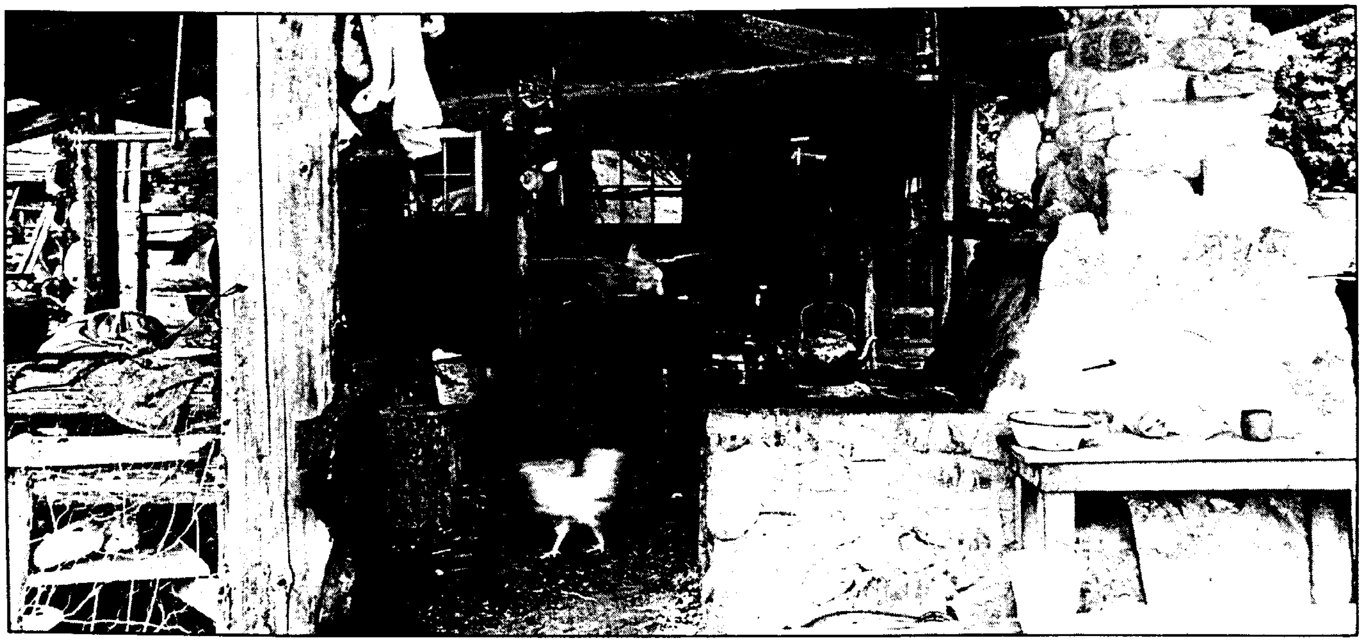


hot drying chambers for drying seeds, herbs or kindling, keeping ceramic dishes warm, or pots with stews and roasts etc. All such chambers, especially if openable on both sides, would circulate warm air into the house and would be very effective in winter. And of course all the massive rock would absorb lots of heat during fire peaks and radiate it out during low fire times or in the night. If such a stove can be made to serve as a backrest to a bench on which you can have your winter breakfast or evening reading-and-writing hours, then I don't have to tell you any longer what I am dreaming of. This would be real economy and wisdom of housekeeping. Russia, China and Korea are known for this kind of stove: in fact, they are built in a way as to provide sleeping area on long broad smoke ducts. (See F. H. King: **Farmers for Fourty Centuries**.)

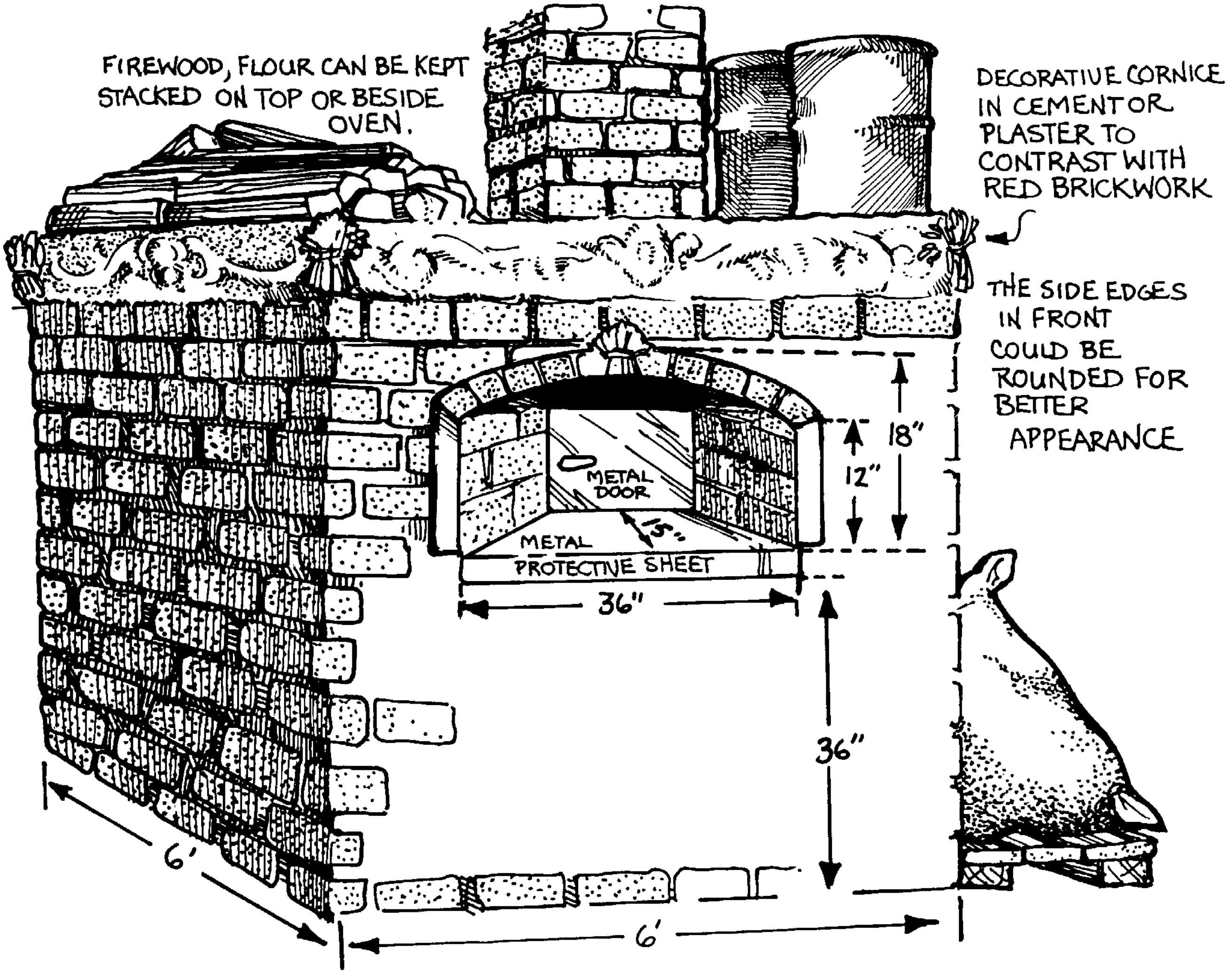
In Germany in previous centuries the tile stove was used. A massive stone and tile structure was built around a firebox with smoke ducts circulating the hot flue gases many times before they were released into the chimney, thus making much more use of the fuel being burned. These stoves are now being torn down because they are considered too clumsy and space wasting; just old castles, palaces and such have them preserved as antiques and museum pieces. People don't realize that their little sheet metal gas and electric heaters and cookers absorb a tremendous amount of their time and space, in terms of their having to go to jobs and factories to earn and exploit the earth to keep them going.

A stove of this sort can also be made as a monolithic concrete structure (with rod or wire reinforcing), totally of red brick or even as a transportable unit of sheet metal. The latter kind would lose the warmth storage capacity and would eventually wear out. I believe it to be important that cooking, baking and heating be combined into one unit. It's nonsense for a homesteader to tend two fires in a small house, or even to build two chimneys in a small house (as I keep seeing lately) to accommodate two stoves.

I hope and wish people with time to spend can experiment and come up with some units that work.



A Large Wood Burning Oven


FIREWOOD, FLOUR CAN BE KEPT STACKED ON TOP OR BESIDE OVEN.
DECORATIVE CORNICE IN CEMENT OR PLASTER TO CONTRAST WITH RED BRICKWORK
THE SIDE EDGES IN FRONT COULD BE ROUNDED FOR BETTER APPEARANCE
METAL DOOR
15"
METAL PROTECTIVE SHEET
18"
12"
36"
36"
6'
6'

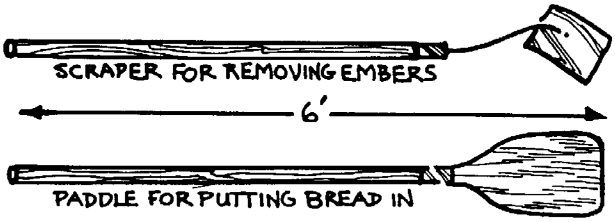
Our oven is of brick-and-mortar construction, a cube measuring 6 feet in every dimension, on the outside. Inside, the oven proper, where the bread is put to bake, measures 4 ft. x 4 ft. or a trifle more. The roof of the baking space is not a dome but a simple arch, high in the middle and sloping to right and left. From front to back there is no slope. The highest point of the arch is 22 inches above the floor. It could be as low as 18 inches. It is not recommended to make the arch more than 24 inches because the higher the arch is, the more firewood is needed to heat the oven and the further away is the source of radiated heat that bakes the tops of the loaves.

The floor of the baking space should be of firebrick if available. Ours is of the hardest ordinary building brick we could find. We chose burnt bricks (which are mostly rejected by masons), not just red baked bricks but bricks burnt black at least in part. As far as possible the same kind of bricks should be used for the arch.

Below the layer of firebricks, or burnt building bricks, or ordinary building bricks, we have a 4 inch layer of sand and crushed glass. This, we were told, retains heat very well, better than plain brickwork. I don't believe it. But since we had plenty of broken window panes and old broken bottles we crushed them all up and mixed them in. Below the sand, if you use it, or below the firebrick, is just plain brickwork right down to the floor of the room.

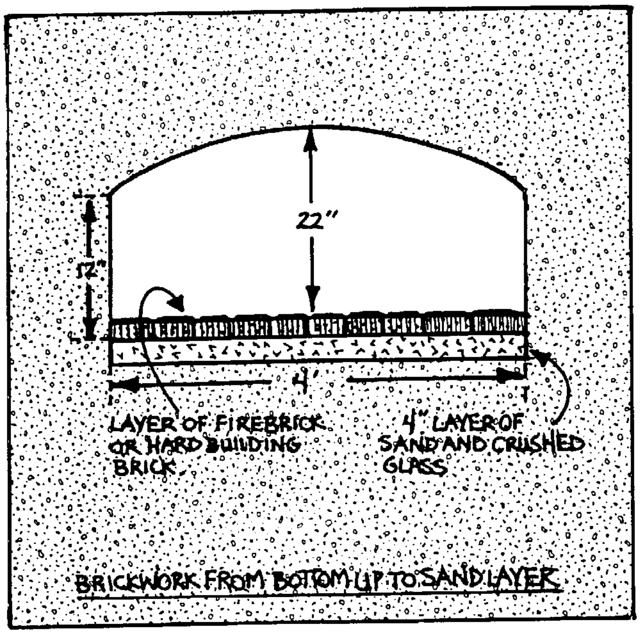
Our chimney is a dream. If you construct your oven well, especially the chimney part, not the faintest wisp of smoke will enter the bakery. After ten years of use the front of our oven is not even the least bit discoloured. The chimney should be constructed outside the oven door and not through the centre of the arch, as some make it. The chimney should have an inside diameter of 9 or 10 inches. Ours rises straight up through the roof. Our bakery is in a one-storeyed building. If yours is not, there should be no difficulty in leading the smoke out by the side wall of the bakery through a metal stovepipe.

Make the door-frame of the oven of 1½" or 2" angle iron with the angle facing the brickwork on all four sides, so that the bricks fit snugly into the angles, and the metal can protect the brick edges from chipping. For the size of opening suit yourself. I recommend 14" wide, so that your 12" baking sheets can fit easily without tilting, and say 12 or 14 inches high. Have four hooks of thin iron rod fixed to the door frame and protruding from it the width of a brick, so as to anchor the frame to the brickwork. Make the door itself of 1/8 inch sheet iron. The bottom of the door frame should be fixed flush with the floor of the oven.



Just outside the oven door is a ledge. (Immediately above this is the chimney.) The inner dimension of the ledge is the same as the width of the door frame. The outer measurement is 3 ft. This is because sideway manoeuvering room is needed to get at the extreme right and left inside the oven. This ledge is protected with a sheet of galvanized iron which bends down for a couple of inches in front as well. As the floor of the oven, so the surface of the ledge also should be flush with the bottom of the door frame. All three should be quite level. This facilitates the shoving in and pulling out of loaves. You need your hardest bricks right opposite the door where most shoving and scraping takes place.

Our oven has no back wall of its own. We built it against the end wall of the room, and for a special purpose. The room behind our bakery is used as a store room for things that need to be kept dry, things like flour, biscuits, cake mixes, spaghetti. If you want a room like this heated by your oven, dig a hole into the wall at the level of the oven floor, 3 ft. long and 18 inches high, leaving only a thin partition (5 inches thick, the width of a brick) between the oven and the room. The room will get very dry and pleasantly warm. To control the admission of heat, put a door to the dug-out space. This room is excellent for drying wet clothes during the rains.


22"
12"
4'
LAYER OF FIREBRICK OR HARD BUILDING BRICK
4" LAYER OF SAND AND CRUSHED GLASS
BRICKWORK FROM BOTTOM UP TO SAND LAYER

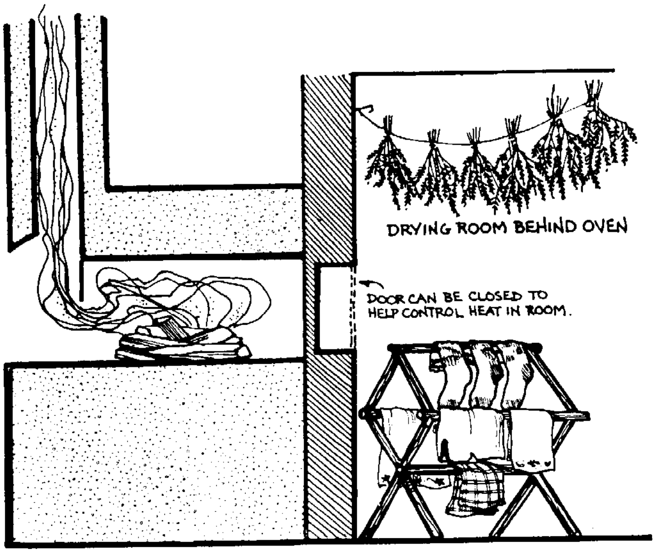
Firewood and sacks of flour can be kept dry either on top of the oven or stacked beside it.

How to Operate the Oven

Build a fire inside the oven with a good armful of logs. Light it and leave the door wide open till the wood has all burnt up. Pull out the embers and ashes and put the bread in. Then close the door.

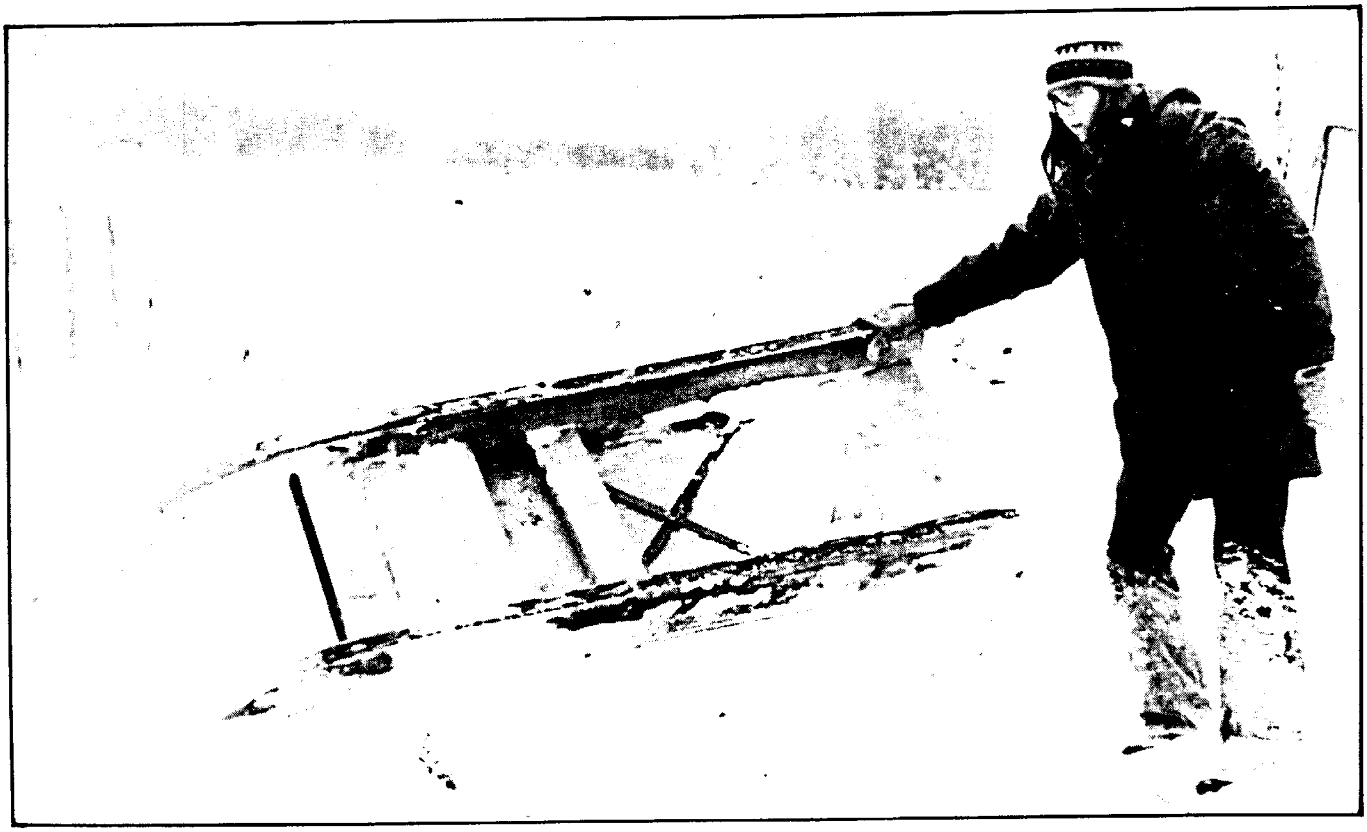
After baking the bread, the oven is still quite hot enough to bake lighter things like cookies, muffins or buns.

The handles for the scraper for removing the embers, and for the paddle for putting in and pulling out the loaves, could be either of light wood or of that light metal tubing used for electric wires. Make them 6 feet long. The paddle blade could be 12 x 8 inches of strong galvanized iron or thin iron sheeting.


DRYING ROOM BEHIND OVEN
DOOR CAN BE CLOSED TO HELP CONTROL HEAT IN ROOM.

A One Pony Sled

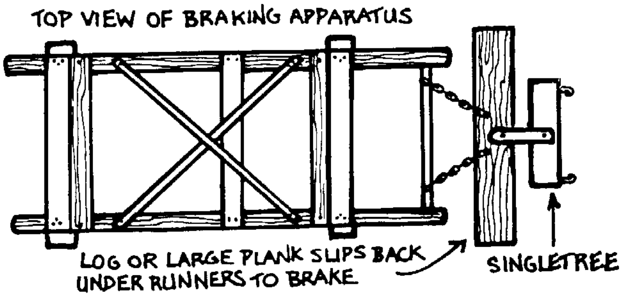
by Greg Bloomberg

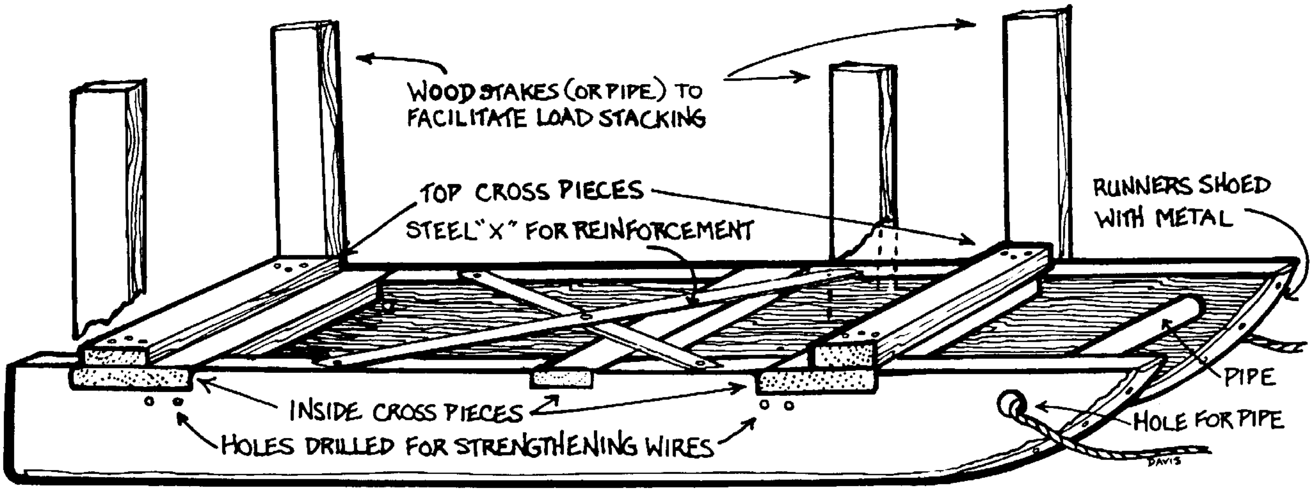


type, you can use both. I had a lot of trouble keeping the side stakes from breaking or coming undone. If you use wood stakes, try nailing them well and then lashing them with strong wire passed through holes drilled in the runners. A better way might be to use lengths of pipe driven into holes drilled in the top of the runners.

To hitch the sled to my pony, I first drilled a hole in the front of each runner and then drove a steel pipe through them. A piece of wire cable was run through this pipe and then through the bolt on a single tree. I used two cable clamps to secure the cable to itself at each end.

If you have steep or long hills to go down, consider using some kind of brake. If you have a team, use a pole and breeching so the horses can hold back on the down grade. You can make a brake as illustrated in Fig. 2. The log or plank used as a brake drops in front of the sled runners to keep it from running up on the horse or team.


TOP VIEW OF BRAKING APPARATUS
LOG OR LARGE PLANK SLIPS BACK UNDER RUNNERS TO BRAKE
SINGLETREE


WOOD STAKES (OR PIPE) TO FACILITATE LOAD STACKING
TOP CROSS PIECES
STEEL "X" FOR REINFORCEMENT
RUNNERS SHOED WITH METAL
PIPE
HOLE FOR PIPE
INSIDE CROSS PIECES
HOLES DRILLED FOR STRENGTHENING WIRES
DAVIS

Building a Hydraulic Ram

by Don Marier

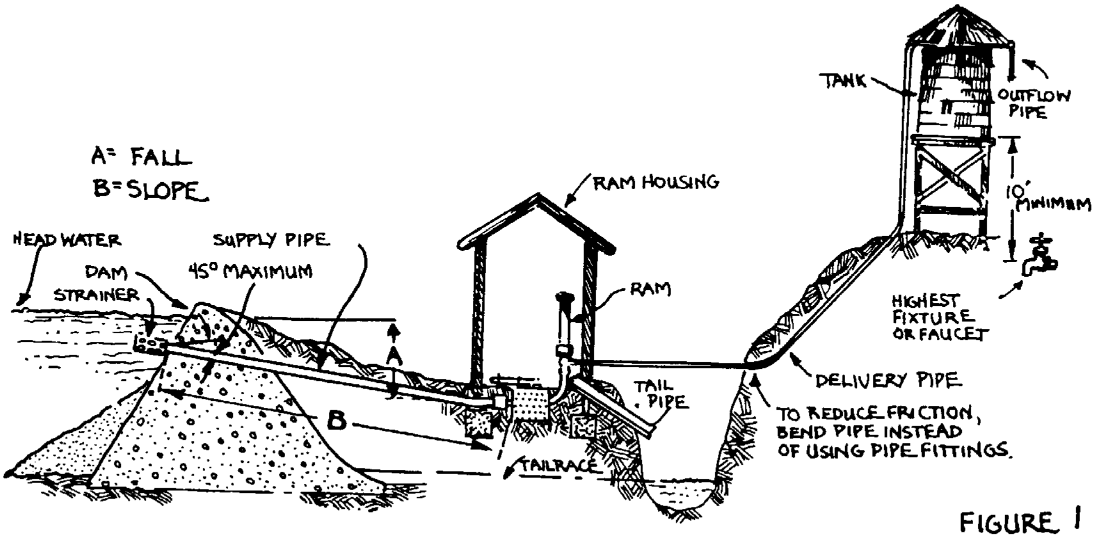


FIGURE 1

I'm always interested in getting something for nothing, so I find hydraulic rams intriguing. They pump water using water – no gas, oil, or electricity is needed. You do need a stream, artesian well, or a spring as a source, though, so not everyone can use one.

The hydraulic ram was invented about 150 years ago and was fairly well widespread in use, until electricity came to the countryside. There are still a few of them around and you may be lucky enough to find one, on an old farm.

I first saw a ram in 1970, when I noticed one in my father-in-law's toolshed in northern Wisconsin. It looked like some type of pump with an octopus- or bulb-shaped chamber on top. My father-in-law still had copies of the sales information on the ram (see references 1 and 2 at end). I was able to get the ram working by reading this information. It's too bad they don't explain how things work anymore.

I took the ram apart, expecting to find a series of chambers and valves inside the bulb, but all I found was one simple leather valve. The leather had lost its zip after 25 years, so I replaced it. With this simple repair done, I installed the ram near a pond with a two-foot dam on it. The ram was irrigating the garden within a few hours.

The ram looked so simple that I began to think of ways to build one out of regular plumbing parts. Two weeks later, I found out that the people at VITA had just put out a manual – **A Hydraulic Ram for Village Use** – on how to do just that(page 52). Since then, I also found a **Popular Science** article on building a ram (page 57). As a future project, I'd like to combine the best of both designs.

I built a ram according to VITA's plans and I'm satisfied with the results. It cost me about $18 worth of parts but that's only about one-tenth the cost of buying a factory-made ram. The parts list calls for regular plumbing parts such as tees, couplings, and bushings. A two-foot section of three-inch pipe with a cap on it serves as the air chamber. The plans are detailed and the parts list is complete.

I made one major modification in VITA's plans that I wouldn't recommend. I used plastic sewer pipe rather than galvanized pipe. I did this because I didn't have the facilities for some of the machining operations called for in the plans and plastic is easier to work with. I got by with this variation, as it turns out, because the ram was operated at very low pressure. If it had operated at higher pressures, chances are it wouldn't have worked. I don't see why plastic **water** pipe wouldn't work, though.

I also modified VITA's plans by using a leather valve from a hand pump rather than the homemade one called for in the plans.

A diagram of a typical ram is shown in Fig. 1. Here's how it works. Water rushes down the drive pipe and escapes out the waste valve until enough pressure is built up to close the waste valve. The amount of this pressure increases as the fall increases. The fall is the vertical distance from the water to the ram.

When the waste valve closes, water is forced through the check valve and into the air chamber. The rushing water compresses the air in the chamber and the compressed air pushes back like a piston. This action closes the check valve and forces water up the delivery pipe to a storage tank.

When the check valve closes, the water in the drive pipe rebounds for a moment. This action created a partial vacuum which allows the waste valve to drop open again. When the waste valve opens, the excess water which was not forced up the delivery pipe flows out of the waste valve. The partial vacuum also draws a small amount of air into the ram through the air valve or "snifter" which is just below the air chamber. This air will be forced into the air chamber when the water starts slowing down the drive pipe again. The air is needed to replenish the air supply in the chamber because some is mixed with the water during each cycle. A small amount of water is lost through the air valve during each cycle but it is very small and it serves to keep the valve clean.

The cycle just described is repeated about 25 to 100 times a minute. How fast it is repeated depends on how much tension is put on the waste valve spring by means of adjusting screws. The slower the ram pumps, the more water it will pump, so the waste valve tension is adjusted for the minimum number of strokes per minute at which the ram will still operate. I had to build the waste valve spring a couple of times so that it lined up properly and had the correct tension. Otherwise, the pressure would not build up properly and the ram would not work.

How much water the ram will pump can be calculated from the following formula:

$$D = \frac{S \times F}{L} \times \frac{2}{3}$$

Where:

D is the amount of water delivered in gal./min.
S is the amount of water supplied to the ram in gal./min.
F is the fall, or the vertical difference in height between the ram and the storage tank
L is the lift, or the vertical distance the water is lifted from the ram to the storage tank
The 2/3 represents the efficiency of the ram. Older rams had efficiences of about 40%

The minimum fall a ram will work with is 18" and this is the fall I had to work with. I measured the supply flow to be 10 gallons per minute by catching the water in a pail and timing how long it took to fill. The lift I used was 10'. Thus the amount of water I should have expected to be delivered was:

$$D = \frac{10 \text{ gal./min.} \times 1\tfrac{1}{2}'}{10 \text{ ft.}} \times 2 = 1 \text{ gal./min.}$$

I actually measured about .5 gallons per minute.

It sounds "inefficient" to use 10 gallons of water to pump one gallon, but if you figured it out, one gallon per minute adds up to 1440 gallons per day, since the ram pumps constantly, unlike a windmill. Besides, that nine gallons which went out the waste valve isn't really wasted since it can be returned to the stream or can be used for any convenient purpose.

You can't pump the water to an indefinite height since pipe friction slows the water down. Friction is kept to a minimum by using sufficiently large pipe and by keeping connections and bends to a minimum. It is much better to bend a long piece of pipe at a gradual angle than to use sections of pipe which are connected together at a sharp angle. The VITA ram calls for a 1½" drive pipe with a 1" delivery pipe. Garden hose is out of the question because all the bends would produce too much friction.

The drive pipe should be between five and ten times the height of the fall and should not be more than 30 degrees from the horizontal. Audel's book on water supply has a good chapter on hydraulic rams. According to Audel, the delivery pipe should not be more 20 times the lift height in length. Also, according to Audel, if a storage tank is used, it should be at least 20' from the highest plumbing outlet. This is to guarantee a minimum of eight pounds of pressure. Storage tanks must be insulated from freezing in cold climates so a better solution might be to use a pressure tank like those used with electric pumps.

Other precautions are to put a small house around the ram to keep it from freezing and to put a piece of screen over the supply pipe intake to prevent leaves from clogging the ram.

The only company I know of that still makes hydraulic rams is the Rife Company. Their rams cost about $180 and up. This is more than the cost of a regular pump but then there are no electricity costs and, with only two moving parts, a ram should last a lifetime. Rife also sells double-acting rams which allow you to pump pure spring water using water from a nearby stream.

My next project is to build another ram based on the VITA and **Popular Science** designs. My objective is to use only parts that can be bought in a hardware store and to limit machining operations to drilling a couple of holes.

References

1. **Gould's Hydraulic Rams**, Gould Pumps, Inc., Seneca Falls, N.Y. (about 1945). No longer available.
2. **Montgomery Ward Hydraulic Rams for Running Water Without Power**, Montgomery Ward Co., Chicago (about 1945). No longer available.
3. **A Hydraulic Ram for Village Use** by Ersal W. Kindel, Volunteers for International Technical Assistance (VITA), 3706 Rhode Island Ave., Mt. Rainier, MD 20822.
4. "Hydraulic Ram Forces Water to Pump Itself", **Popular Science**, by A. W. Kaufmann, October 1948, pp 231-233.
5. **Domestic Water Supply and Sewage Disposal Guide**, by Edwin P. Anderson. Theodore Audel & Co., New York, 1967. (Chapt. 10 is on hydraulic rams.)
6. **Manual of Information: Rife Hydraulic Water Rams**, Rife Hydraulic Engine Mfg. Co., Box 367, Millburn, NJ 07041. 1968.

A Village Ram

by Ersal Kindel

A hydraulic ram is a simple device, invented about 150 years ago. It uses the power from falling water to force a small portion of the water to a height greater than the source. Water can be forced about as far horizontally as you desire, but greater distances require larger pipe, due to friction. There is no external power needed and the ram has only two working parts. The only maintenance needed is to keep leaves and trash cleaned away from the strainer on the intake and to replace the clack and non-return or delivery valve rubbers if they get worn. The original cost is almost the only cost.

Two things are needed to make the ram work: (a) enough water to run the ram and (b) enough height for water to fall through the drive pipe to work the ram. A small amount of water with plenty of fall will pump as much water as a greater amount of water with only a little fall. The greater the height to which the water must be raised, the less water will be pumped, under a given set of circumstances.

Water may come from a spring on a hillside or from a river. It must be led into a position from which it can pass through a relatively short supply pipe to the ram, at a fairly steep angle (about 30 degrees from the horizontal is good). Often a catch basin or cistern is used as the source for the drive pipe, but an open ditch such as that which supplies a water posho mill could be used. Be sure to put a strainer on the top of the drive pipe to keep trash out of the pipe and ram.

The water starts to run down through the drive pipe, going faster and faster till it forces the automatic valve or clack to close suddenly. The weight of the moving water, suddenly stopped, creates very high pressure and forces some of the water past the non-return or delivery valve and into the air chamber, compressing the air more and more till the energy of the moving water is spent. This compressed air acts as a spring and forces the water up the delivery pipe to the storage tank in a steady stream. It takes a lot of falling water to pump a little water up a hill. Often about one part in ten is delivered to the storage tank at the top of the delivery pipe. The snifter hole wastes a bit of water but takes in a bubble of air with each stroke. This is necessary to keep air in the air dome and it must not get plugged or the air dome will get filled with water and the ram will stop. The small ram works best at about 75 to 90 strokes per minute, depending on the amount of drive water available. The slower it goes, the more water it uses but the more it pumps.

Any working fall from 18" to 100' can be used to work a ram, but in general, the more working fall you obtain, the less the ram will cost and the less drive water it will require to raise a given amount of water. If there is plenty of water, a fall of four feet could be made to raise water 800' but this would be an expensive installation.

Our ram at Kaimosi farm is a very small one and has a small amount of water to run it, but there is plenty of fall and not very much lift.

Head 20', lift 44' uses 8.4 gal./min.

Drive pipe 85', run 690', delivers 1-2/3 gal./min.
= 100 gal./hr. or 2400 gal. in 24 hr.

Unless you have practically unlimited water available, measure it exactly by making a temporary dam and putting a large pipe or two through it. Then catch and measure the water for, say, 15 minutes. Next sight along a carpenter's level to the top of a 10 ft. pole set on the ground down the hill at a lower level. Then move the level to the pole's position and sight again to the top of the pole, finding how many levels or fractions you have, and this will give you when added together, the amount of fall for the drive pipe. Do the same for the height to which the water must be raised. This height is measured from the ram level. For a more elaborate method of measuring fall, refer to **Cloudburst 1**, page 43.

A factory-built ram is more efficient but costs more. This small ram you can make up yourself from pipe fittings and you only have to buy or build the clack and delivery valve assemblies.

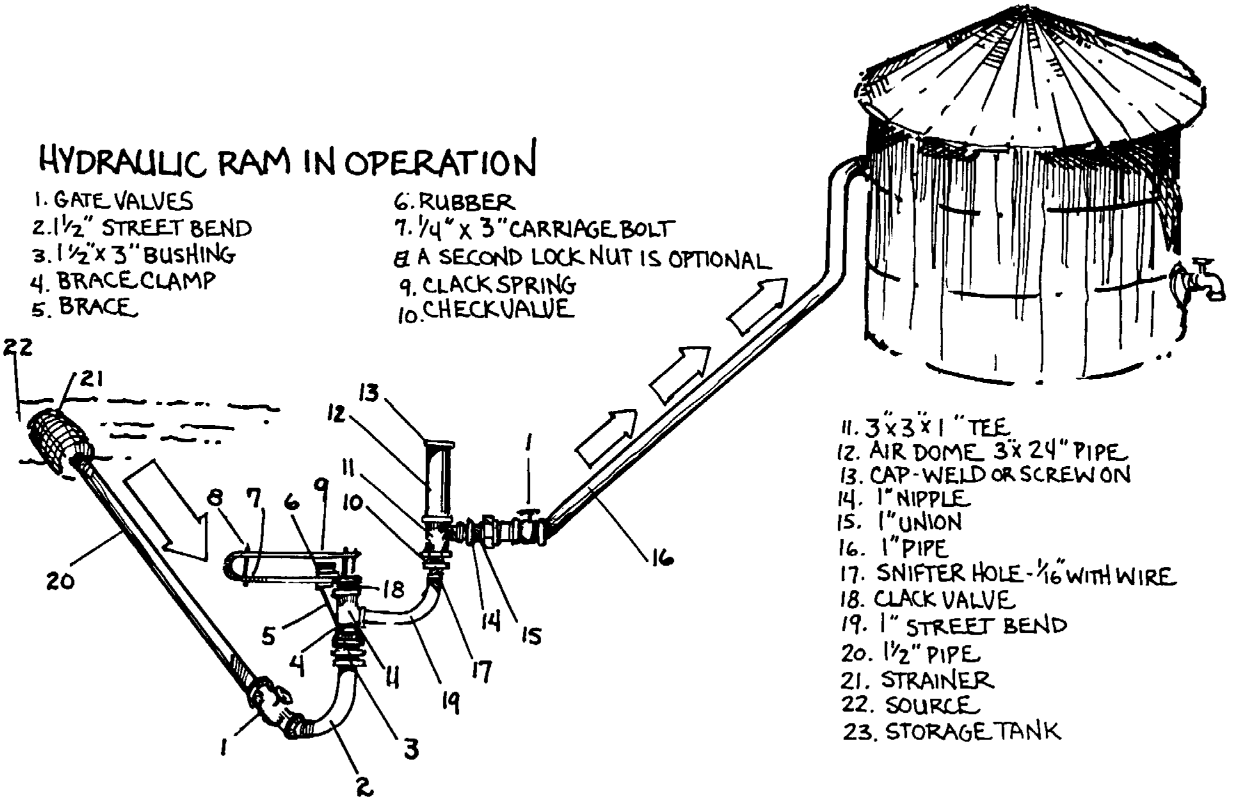
Building the Ram

Start by building the clack valve. If you do not have a metal lathe, a machine shop will do the work for a small price. Chuck a 3" x 1" pipe bushing in the lathe and turn the inside smooth, where the clack strikes. Turn out the threads and eliminate any sharp edges. Drill two ¼" holes near the end of a piece of strap iron ¼" x 1½" x 2" and, using it as a template, drill and tap holes in the top of the pipe bushing. Grind off the galvanizing, then bolt the clack spring support solidly to the bushing and braze it also. Bend a 36" iron strap, 1½" x 1/8", around a 2" pipe to make the clack spring. Drill two ½" holes through the end and also through both the support and two short pieces to make up the pad as shown in the drawing. Cut pieces of rubber inner tube and assemble the sandwich. This is to keep vibration from breaking the support off the pipe bushing. A brace can be added for additional support but is not absolutely necessary.

The clack valve itself is made up of a rubber disc and metal washer 3/8" smaller than the inside of your bushing and assembled on a 3/8" x 4½" bolt. The best rubber I have found is from an old tractor tire – it shows no wear at all after 8 months' use. I cut it on a band saw and sanded it flat and even on a disc sander with coarse paper. A similar one is used for the check valve. Slip a washer over the bolt and a short length of thin wall steel tube (¾" o.d. conduit) with the ends filed exactly square. Then put it through a hole in the clack spring. Adjust by bending so the rubber clack strikes true and doesn't rub on the sides of the bushing.

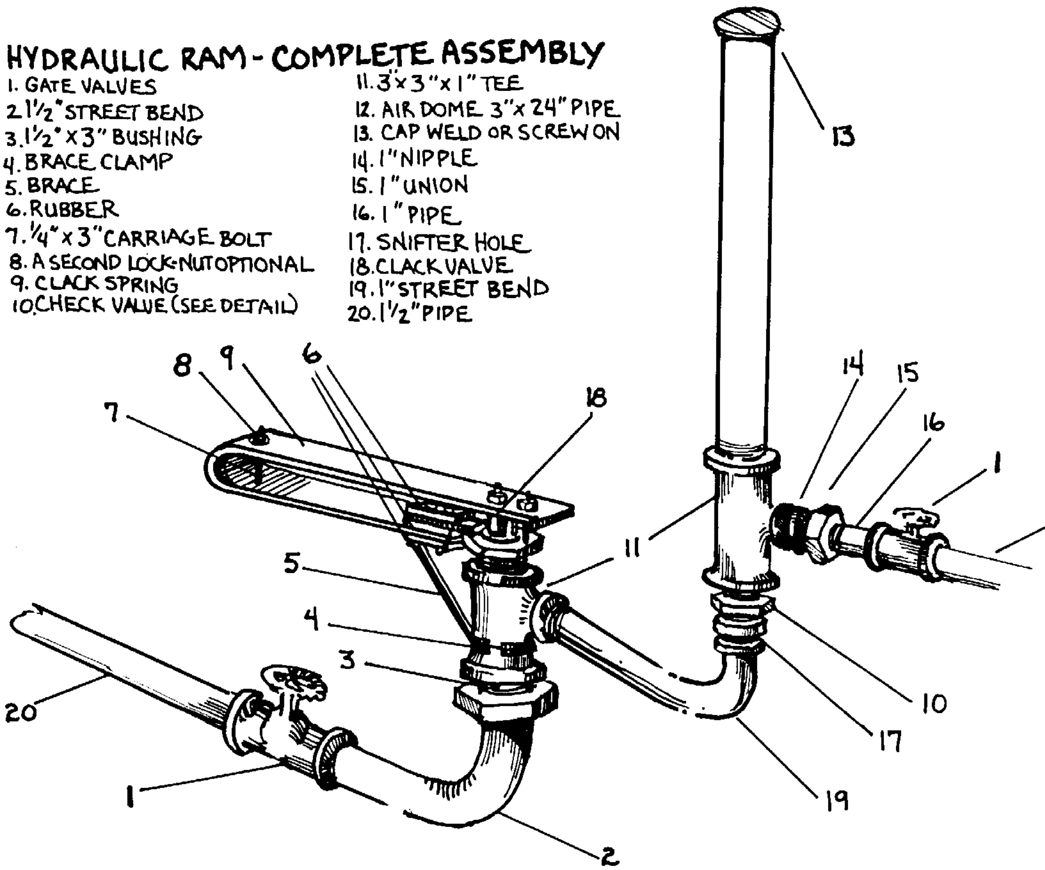
Drill a hole for a carriage bolt to adjust the stroke of the spring; also a pair of holes about three inches from the round end of the spring for a tension bolt. If the bottom hole is filed square to fit the under side of the bolt, it will not turn when adjustments are made.

The check valve is similar in construction but a ½" x 2" galvanized bolt is used. Machine the lip true where the valve rests but do not cut it down farther than necessary. This gives



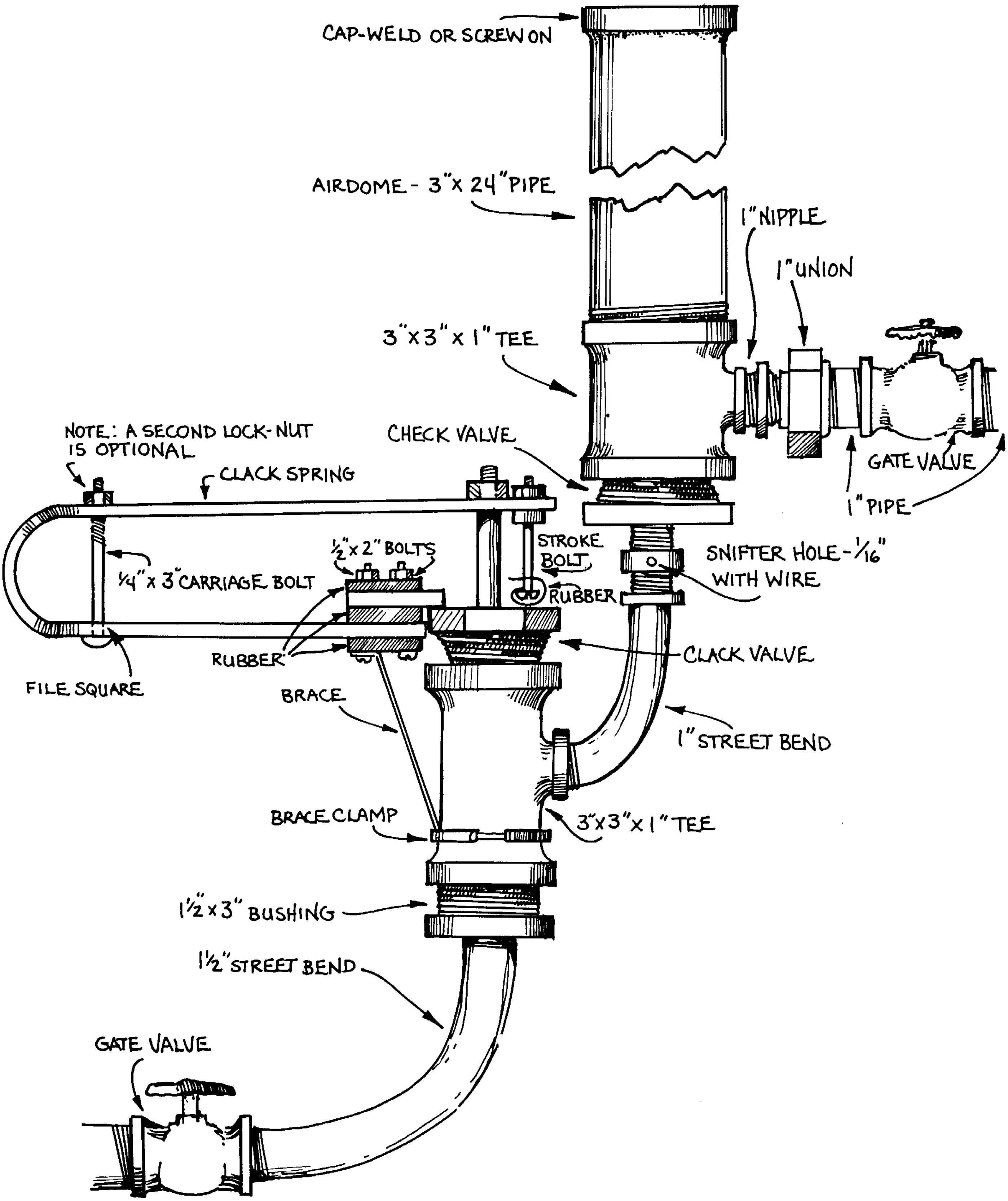
HYDRAULIC RAM IN OPERATION

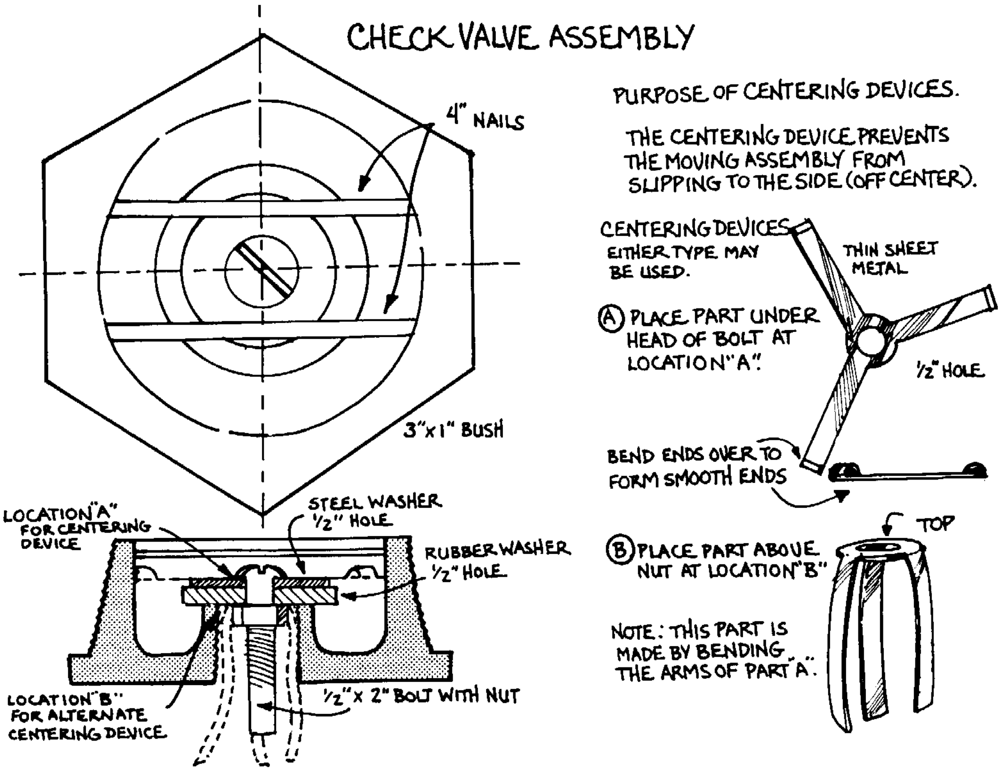
1. GATE VALVES
2. 1½" STREET BEND
3. 1½"x 3" BUSHING
4. BRACE CLAMP
5. BRACE
6. RUBBER
7. ¼" x 3" CARRIAGE BOLT
8. A SECOND LOCK NUT IS OPTIONAL
9. CLACK SPRING
10. CHECK VALVE
11. 3"x 3"x 1" TEE
12. AIR DOME 3"x 24" PIPE
13. CAP-WELD OR SCREW ON
14. 1" NIPPLE
15. 1" UNION
16. 1" PIPE
17. SNIFTER HOLE-1/16" WITH WIRE
18. CLACK VALVE
19. 1" STREET BEND
20. 1½" PIPE
21. STRAINER
22. SOURCE
23. STORAGE TANK



HYDRAULIC RAM - COMPLETE ASSEMBLY

1. GATE VALVES
2. 1½" STREET BEND
3. 1½" x 3" BUSHING
4. BRACE CLAMP
5. BRACE
6. RUBBER
7. ¼" x 3" CARRIAGE BOLT
8. A SECOND LOCK-NUT OPTIONAL
9. CLACK SPRING
10. CHECK VALVE (SEE DETAIL)
11. 3"x 3" x 1" TEE
12. AIR DOME 3"x 24" PIPE
13. CAP WELD OR SCREW ON
14. 1" NIPPLE
15. 1" UNION
16. 1" PIPE
17. SNIFTER HOLE
18. CLACK VALVE
19. 1" STREET BEND
20. 1½" PIPE


CAP-WELD OR SCREW ON
AIRDOME - 3" x 24" PIPE
1" NIPPLE
1" UNION
3" x 3" x 1" TEE
NOTE: A SECOND LOCK-NUT IS OPTIONAL
CHECK VALVE
GATE VALVE
1" PIPE
CLACK SPRING
STROKE BOLT
SNIFTER HOLE - 1/16" WITH WIRE
1/2" x 2" BOLTS
1/4" x 3" CARRIAGE BOLT
RUBBER
RUBBER
CLACK VALVE
FILE SQUARE
BRACE
1" STREET BEND
BRACE CLAMP
3" x 3" x 1" TEE
1 1/2" x 3" BUSHING
1 1/2" STREET BEND
GATE VALVE


CHECK VALVE ASSEMBLY
4" NAILS
3"x1" BUSH
LOCATION "A" FOR CENTERING DEVICE
STEEL WASHER ½" HOLE
RUBBER WASHER ½" HOLE
LOCATION "B" FOR ALTERNATE CENTERING DEVICE
½"x 2" BOLT WITH NUT
PURPOSE OF CENTERING DEVICES.
THE CENTERING DEVICE PREVENTS THE MOVING ASSEMBLY FROM SLIPPING TO THE SIDE (OFF CENTER).
CENTERING DEVICES EITHER TYPE MAY BE USED.
THIN SHEET METAL
Ⓐ PLACE PART UNDER HEAD OF BOLT AT LOCATION "A".
½" HOLE
BEND ENDS OVER TO FORM SMOOTH ENDS
TOP
Ⓑ PLACE PART ABOVE NUT AT LOCATION "B"
NOTE: THIS PART IS MADE BY BENDING THE ARMS OF PART A.

a bit of clearance for the water to pass. Drill two holes on each side of the middle for a 4" common nail to pass just above the valve metal washer, to keep it in place. Leave enough clearance so the valve can open just about 1/16". Spread the bolt with a centre punch just below the nut, so the nut can't work loose. Cut the nails off and file threads across their ends so the bushing will screw into the tee above it.

Just one other small job before assembly: Drill a 1/16" hole in the centre of the 1" nipple just below the check valve and bend a piece of copper wire to the shape of a cotter pin and insert it from the inside of the nipple with long nosed pliers. Spread the outside ends. This copper wire restricts the jet of water coming out, yet moves enough to keep the hole clean, most always.

The air dome can be a 2' length of 3" pipe, threaded on both ends with a cap on the top end, or the top end can have a plate welded over it. It must be airtight at great pressure. I coated the inside of the pipe with asphalt paint to protect it from rust and to seal any small leaks in the weld. Let it dry in the sun while assembling the rest of the ram.

Assembly

Use plenty of good grade pipe joint compound, both on inside and outside threads. Screw things together firmly but not excessively tight, and leave them in the correct position for your installation. Set the ram reasonably level but nothing is demanding in this respect. The snifter hole must be immediately below the air dome so the bubbles will go up into the dome. Clack and check valves must be free from binding and touch evenly all around. The old tractor tire rubber with some fabric on the back seems to be just the right toughness and resiliency to last a long time – much longer than either gasket rubber or live rubber.

I find no reason at all to mount the ram in concrete as has been suggested – in fact it is a convenience to be able to shut off the two valves, loosen the unions, and take the ram to the shop for cleaning and painting. Painting of course doesn't help its working but it does make it look better when visitors go to see it. The cost of a home built ram is about a tenth the manufactured cost and it works on at no cost at all. A bit of rubber stretched over the head of the stroke bolt quiets the ram but isn't essential. Adjust the spring tension bolt and stroke bolt together to get the best period for your particular ram. Support the drive and delivery pipes so they don't bounce and vibrate.

This is a small ram but larger ones can be built – we have built two with 3" drive pipe and correspondingly larger ram parts. One lifts water about 150' and drives it through 3600' of pipe.

Installation & Adjustments

The drive pipe should have a strainer on the top made of ½" coffee tray wire, hardware cloth or anything suitable. This keeps out trash, frogs and leaves, any of which will stop the ram if they get inside. The drive pipe should be 1½" or larger (we use 2" pipe) and, if possible, new, solidly put together, straight, and well supported through its length. A gate valve on the drive pipe about 4' from the ram is a great convenience but not necessary. Another gate valve on the delivery pipe is almost a necessity to avoid draining the entire delivery pipe whenever the ram is cleaned. The ram should be connected to the delivery and drive pipes by unions so it can be removed for cleaning. If it is desirable to use two rams, they must have separate drive pipes, but the delivery pipes can be joined, provided the pipe is large enough to carry the water.

The delivery pipe should start from the ram with about two lengths of 1" galvanized iron pipe. From there ¾" plastic pipe can be used. The iron pipe will give the ram better support, but plastic pipe is smoother inside and can be a size smaller than the iron pipe. Also, plastic pipe is cheaper, but it must be protected from mechanical injury and sunlight. Do not take any branches off the supply line at less than three times the working fall, or when the tap is turned on the ram will stop. (A float valve might be an exception.) Best results will be obtained by putting all the water from the ram directly into a storage tank and using it from there. Use the overflow to irrigate the pasture.

The small bolt at the end of the clack spring controls the length of the stroke of the clack spring. Experiment for the best length of stroke and tension for your set of conditions. Adjust the length of stroke first, then the spring tension. The greater the tension and length of stroke, the slower the ram will work and the more water it will pump, but it will take more water to keep it working.

If Action is Faulty

See that the clack valve closes squarely, evenly and completely. If it does not, the clack spring may have been bent somehow, and it will have to be straightened.

See that the clack valve does not rub on the front, side or back of the valve body.

Check for trash in the ram or delivery valve or snifter hole.

Check to see that the air dome is not filled with water. It must not be full of water or the ram will knock loudly and may break something. The snifter lets in a bit of air between each of the strokes and this keeps the dome full of compressed air.

Check rubber clack and delivery valve for wear or looseness.

If drive water is in small supply, speed up the stroke by loosening spring tension and shorten the stroke by lowering the stroke adjusting bolt. More water is delivered by a faster stroke and continuous running than a slower stroke that stops every day.

Check for leaks in the drive pipe. If air bubbles come out of the drive pipe after it has been stopped for a while, air is leaking into the drive pipe and the ram action is spoiled.

Clean the ram once in a while. It deserves it after working without rest day and night for weeks and months on end. Protect it from outside injury and inquisitive children.

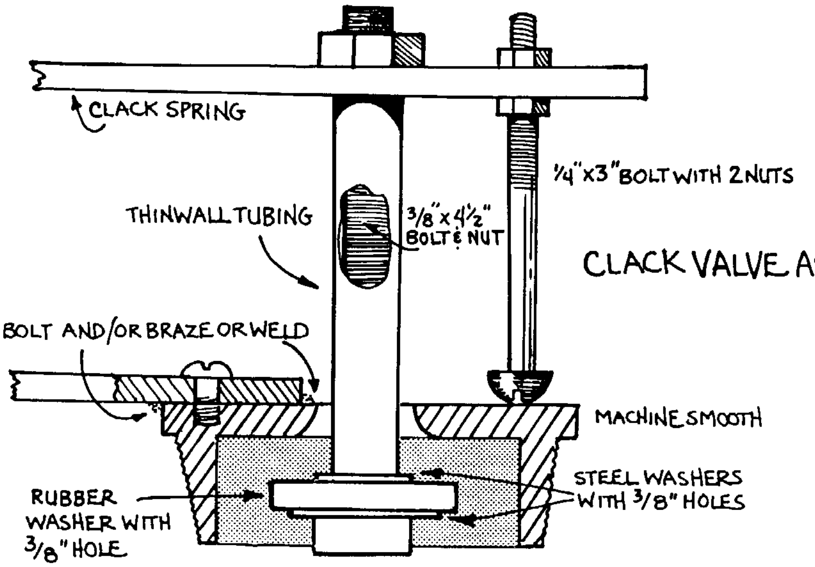
When the ram runs out of water, it will usually stop, remaining open and losing all the water available until it is closed again. You can listen at the storage tank to hear if it is still running and, if it isn't, go to the ram and close the drive pipe until water has accumulated in the cistern.

Long delivery distances require larger pipe to reduce friction.

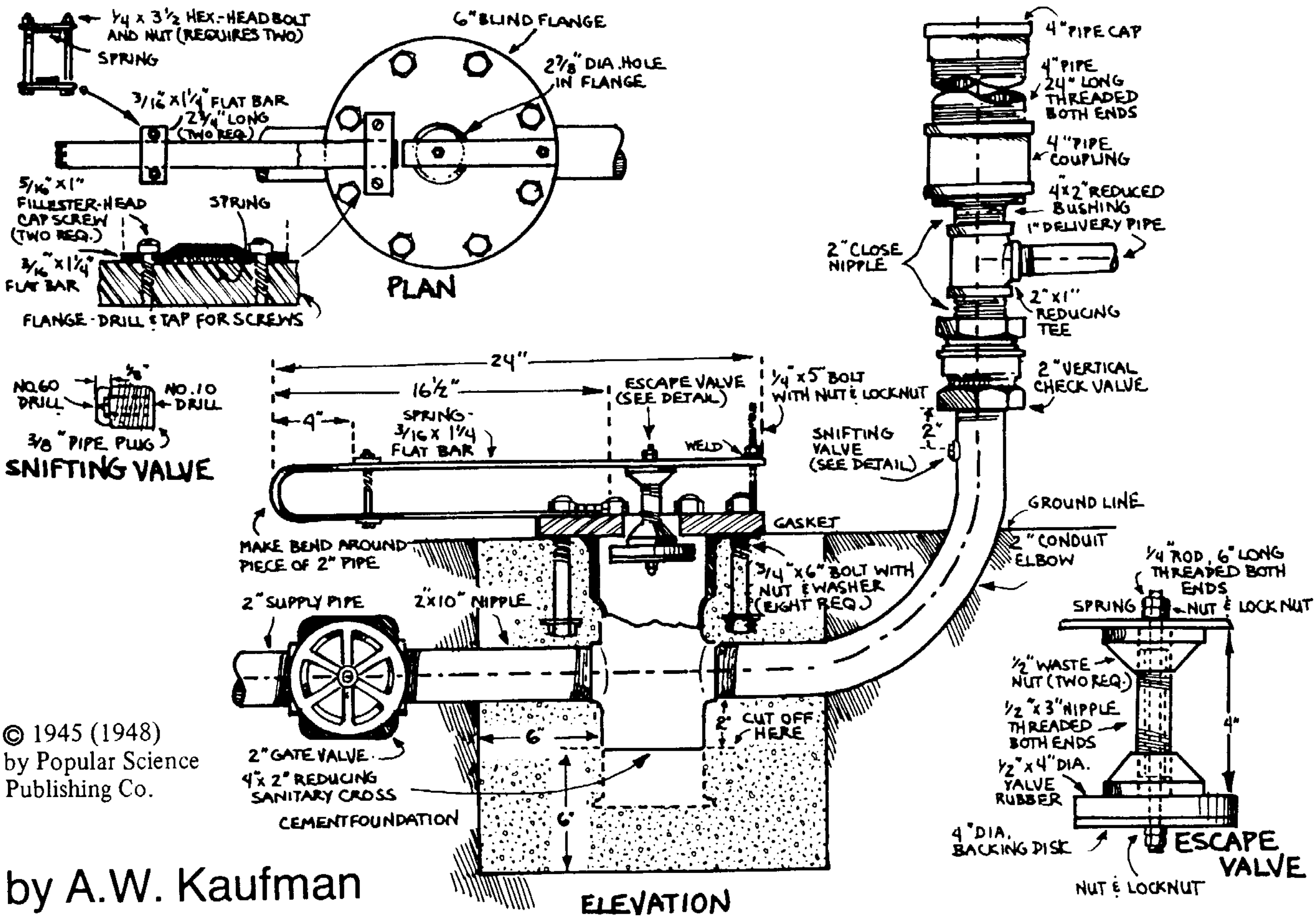
A cistern is a good thing to have at the top of the drive pipe to let dirt settle out of the water. The outlet from the cistern to the ram should be a foot or so above the bottom to allow room for dirt to settle out. A cleaning drain in the bottom is good.

Parts List

Quan.	Part
1	1½" valve
1	1½" street bend
1	1½" x 3" bushing
1	Brace
1	Brace clamp
2	3" x 3" x 1" tees
1	¼" x 3" carriage bolt & nut (2 nuts optional for lock-nut)
1	Clack spring
3	Rectangular pieces of rubber
2	½" x 2" bolts with nuts
1	3" x 24" pipe
1	Cap for air dome
2	3" x 1" bushings
1	Sheet metal disc about 2¼" in diameter
1	½" x 2" bolt with nut
1	Rubber washer, 1¾" dia., ½" hole
2	4" nails
1	¼" x 3" bolt with 2 nuts
1	3/8" x 4½" bolt with nut
1	¾" dia. x about 4" long thinwall tubing
1	Rubber washer, 1¾" dia., 3/8" hole
1	Steel washer, about ¾" dia., 3/8" hole
1	Steel washer, about 1¼" dia., 3/8" hole
1	1" valve
1	1" union
2	1" nipples
1	Small piece of rubber for stroke bolt
1	1" street bend
1	Short piece of 3/32" wire for snifter hole
1	Steel washer, ½" hole


CLACK SPRING
¼"x3" BOLT WITH 2 NUTS
THINWALL TUBING
3/8"x4½" BOLT & NUT
BOLT AND/OR BRAZE OR WELD
MACHINE SMOOTH
RUBBER WASHER WITH 3/8" HOLE
STEEL WASHERS WITH 3/8" HOLES

CLACK VALVE ASSEMBLY


1/4 x 3 1/2 HEX.-HEAD BOLT AND NUT (REQUIRES TWO)
SPRING
3/16" x 1 1/4" FLAT BAR 2 3/4" LONG (TWO REQ.)
6" BLIND FLANGE
2 7/8" DIA. HOLE IN FLANGE
5/16" x 1" FILLESTER-HEAD CAP SCREW (TWO REQ.)
SPRING
3/16" x 1 1/4" FLAT BAR
FLANGE - DRILL & TAP FOR SCREWS
PLAN
4" PIPE CAP
4" PIPE 24" LONG THREADED BOTH ENDS
4" PIPE COUPLING
4" x 2" REDUCED BUSHING
1" DELIVERY PIPE
2" CLOSE NIPPLE
2" x 1" REDUCING TEE
2" VERTICAL CHECK VALVE
NO. 60 DRILL
1/8"
NO. 10 DRILL
3/8" PIPE PLUG
SNIFTING VALVE
24"
16 1/2"
4"
SPRING - 3/16 x 1 1/4 FLAT BAR
ESCAPE VALVE (SEE DETAIL)
1/4" x 5" BOLT WITH NUT & LOCKNUT
WELD
SNIFTING VALVE (SEE DETAIL)
2"
GROUND LINE
GASKET
MAKE BEND AROUND PIECE OF 2" PIPE
3/4" x 6" BOLT WITH NUT & WASHER (EIGHT REQ.)
2" CONDUIT ELBOW
2" SUPPLY PIPE
2" x 10" NIPPLE
2" CUT OFF HERE
6"
6"
2" GATE VALVE
4" x 2" REDUCING SANITARY CROSS
CEMENT FOUNDATION
ELEVATION
1/4" ROD, 6" LONG THREADED BOTH ENDS
SPRING
NUT & LOCK NUT
1/2" WASTE NUT (TWO REQ.)
1/2" x 3" NIPPLE THREADED BOTH ENDS
4"
1/2" x 4" DIA. VALVE RUBBER
4" DIA. BACKING DISK
NUT & LOCKNUT
ESCAPE VALVE

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Publishing Co.

by A.W. Kaufman

The Popular Science Ram

A small but efficient ram may easily be built at home. For the base, use a 2" x 4" cast-iron reducing sanitary cross. Saw off the small 4" end 2" below the threads. Face or dress the bell end flat and true.

Make the spring, strap, and clamp from 3/16" x 1¼" galvanized flat-bar stock. For the escape valve, assemble a ½" x 3" nipple, ½" galvanized waste nuts with the ears cut off, a 4" valve rubber, and a backing disk. A ¼" rod threaded at each end holds the assembly together.

The flange is made from a blind flange for 6" pipe. Drill a 2-7/8" hole in the centre and drill and tap two holes for the 5/16" cap screws that retain the spring. Carefully dress one side of the flange to provide a smooth valve seat.

Assemble the cross with a 2" x 10" nipple and a 2" conduit elbow. Tap the latter for 3/8" pipe about 2" below the threads at one end for the snifting valve.

Invert this assembly on the flange, with the bolts and clamp screws in place. Centre the anchor bolts in the flange holes with tape, and wire the washers in position. Stuff the interior of the cross with crumpled newspaper, topping off the stuffing with a small piece of chicken wire. Also wrap several layers of wire fencing loosely around the cross to reinforce the cement. Then build a wood form to enclose the cross.

The cement block must supply a solidity and mass that absorbs the ramming shocks of the water. Hence it should be carefully made. Thoroughly mix equal parts of sharp coarse plaster sand and lump-free cement. Wet slowly until jellylike and tamp into the mold. When the cement has set, knock off the form, remove the flange and the newspaper stuffing, and fill the interior with cement up to the lower level of the inside of the 2" pipes. Smooth this to reduce friction.

The ram is now ready for installation. Lay a 2" supply pipe of a length equal to the height the water must be raised, keeping it straight and uniformly slanted. The fall should be as great as possible.

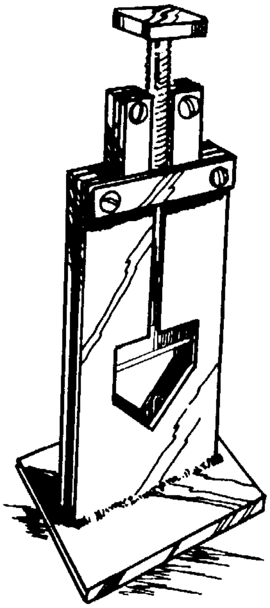
Cement the ram in position, connect the supply pipe, fit a gasket to the top of the cross, and bolt on the flange. Then assemble the escape valve and spring. Finally, attach the check valve and the capped 4" x 24" pipe nipple that functions as an air dome.

To start operation, open the gate valve, permitting the water to close the escape valve. Then push the escape valve open and allow the water pressure to close it. Repeat this action several times and the ram should pick up the cycle and operate automatically thereafter.

If you house the ram and use a tail pipe to carry away the waste water that flows out of the ram, be careful to locate the tail pipe high enough so it won't be submerged in times of flood.

A Chicken Guillotine

by Larry McWilliams



© 1974 by Larry McWilliams

Quite a number of people ask for a poultry killer of this fashion. I hope you won't mind if I go ahead and try to convince people with guineas, turkeys, pigeons, ducks, etc. that they should give it a try too. I've even included a drawing with the dimensions for a guillotine that can be used for rabbits. The latter is the same machine except that the width of the steel plates has been changed to allow a larger hole and blade.

To start with I might mention that this item has been designed for a lifetime of use and maybe even your children's lifetime. It's constructed entirely of ¼ inch plate steel and is designed so that the plunger and blade assembly can easily be removed for sharpening. Probably the easiest way to build this contraption would be to first cut out all the necessary parts. When doing this please note that the vertical slot on side 1 is cut at an angle of 45° to the inside. Note the plan view. Also there are four spacer blocks which can be made of a piece of 1/4 inch plate plus a piece of 1/32 inch metal or you can use four pieces of 9/32 inch thick steel. The purpose of these spacers is to give a space of 1/32 inch inside the slot where the blade is moving. This should promote a smooth operating plunger.

The other critical point will be where the blade is welded to the 1/2 inch plunger rod. The weld must be ground down well until the assembly will move smoothly up and down the slot made for it. When cutting the parts for the base and handle you can round off the corners a bit if you want. Smooth down all rough edges and sharp corners except the opening on side 2. You want a good straight edge on the side which will contact the blade so you will get a good sheer action.

Lastly drill four holes in the base plate so that it can be bolted to a plank or table.

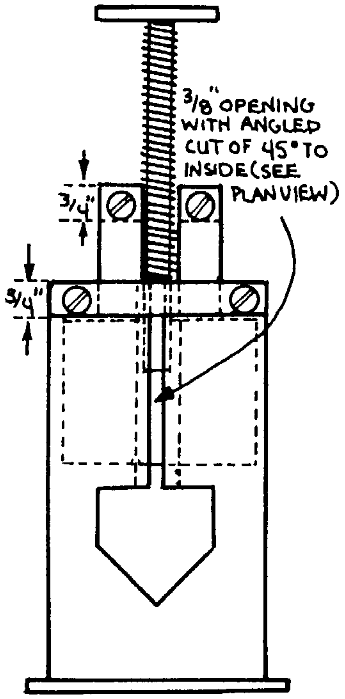
To start assemblying your guillotine clamp one of the uprights to the base in the proper position with a piece of angle iron. Make sure the angle is a true 90° after it is clamped. Weld the first upright to the base with the weld being on the outside. Next use a couple of the spacers which you've made to space the bottom of the uprights apart the proper distance and clamp to the upright which is already welded. Now you can weld the second upright and remove the spacers.

Next you'll have to make sure that you have a proper fit between the plunger and the uprights. When this is done you can put on the spring and install the plunger and blade assembly.

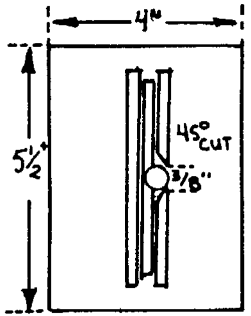
Right here I would like to say a couple of things about this spring. It should be a compression type srping with an inside diameter of 1/2 inch or just slightly larger. It needn't be a real strong spring as all it needs to do is return the plunger and keep it up. If you use a spring that is stronger than necessary then it will just be harder for you to push the plunger down. To put the spring on the rod wrap one end around the rod and then just screw it on like screwing on a jar lid. Put the plunger assembly in between the uprights, insert the spacers and bolt them together. You might want to add lock washers to all of the bolts just to be on the safe side. Before putting on the spring you might want to oil or grease the rod and lubricate the insides of the uprights with a light oil. A light machine oil in a small spray bottle will cover all the parts and protect them from rusting. It would be a good idea to lubricate the guillotine after each washing also.

Well there you have it. The whole thing can be taken apart quite easily to sharpen the blade or for a thorough washing and relubrication. For you rabbit people who raise large breeds or just need a larger opening than the one shown on the drawing for the rabbit guillotine I've also noted the largest possible opening for that machine. By all means try to make a v shape at the bottom of the opening though. This helps the sheer action of the blade when cutting.

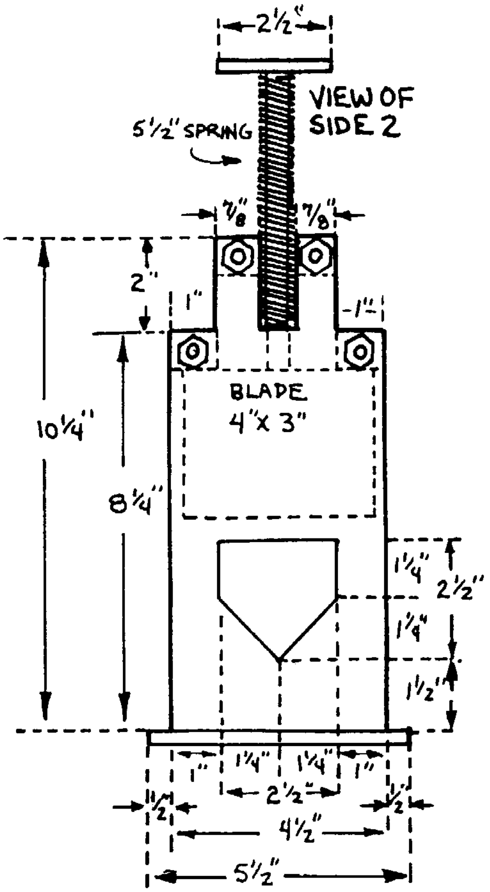
After assembling the guillotine you can mount it to a 2"x6" or a 2"x8" plank and use it over a barrel in which you can drop the poultry so they won't thrash around so much.

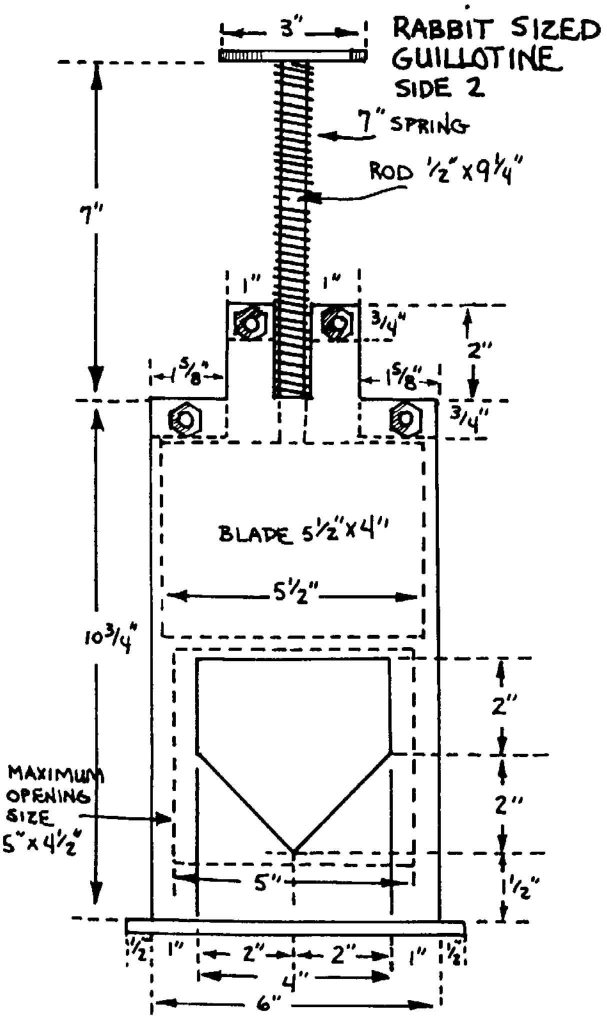

3/8" OPENING WITH ANGLED CUT OF 45° TO INSIDE (SEE PLAN VIEW)
3/4"
3/4"

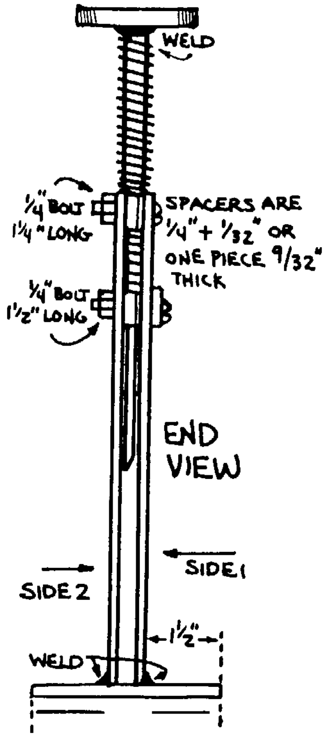
VIEW OF SIDE 1

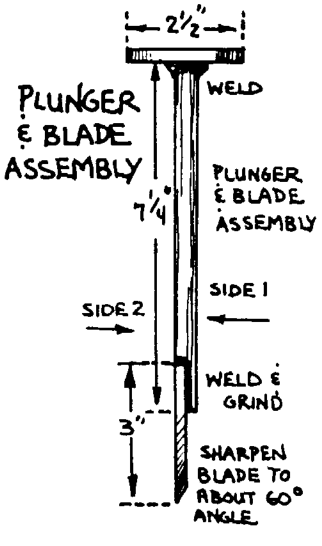


PLAN VIEW



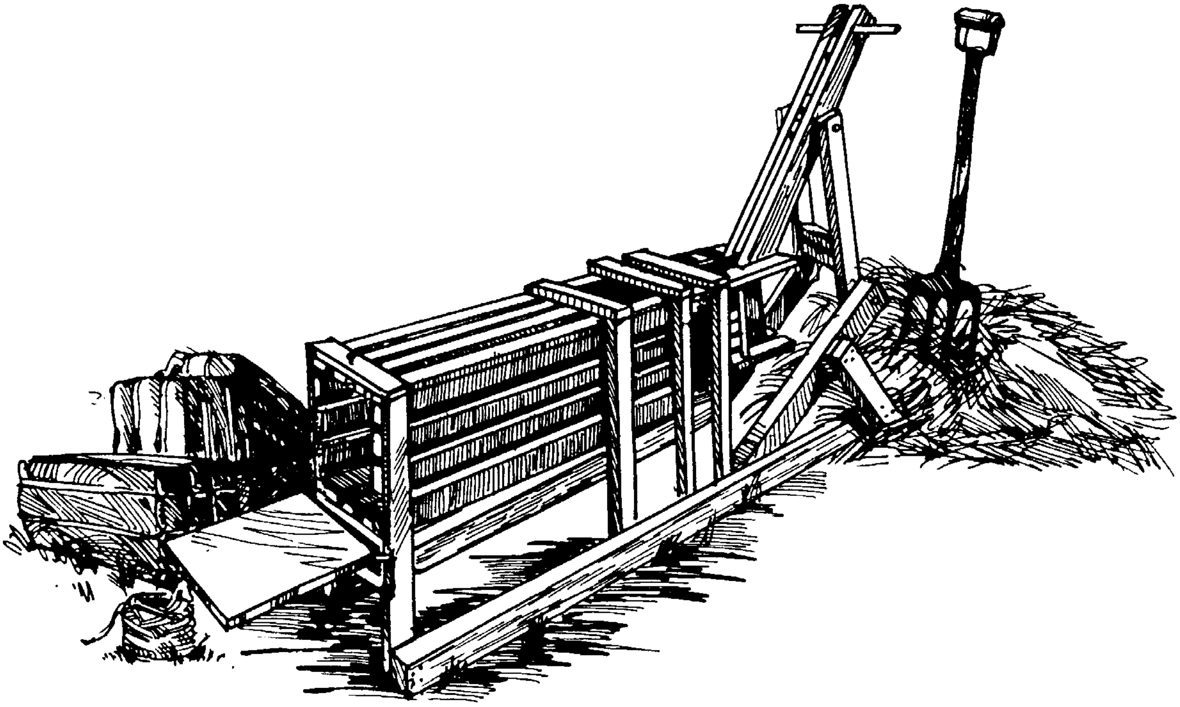






A Hand Powered Hay and Leaf Baler

by Larry McWilliams



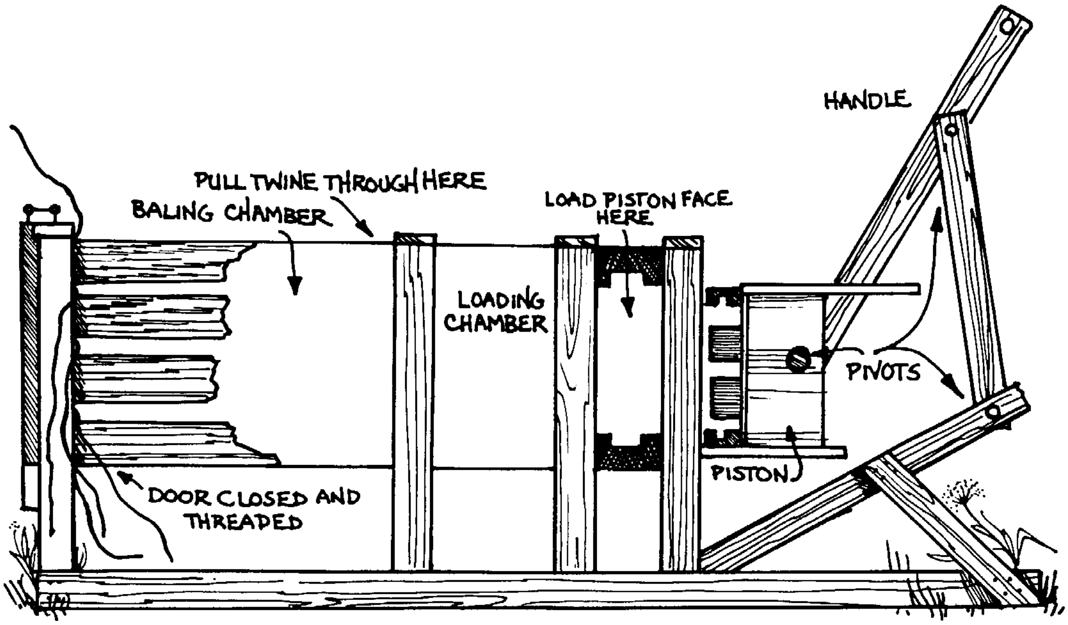
©1974 by Larry McWilliams

Many homesteads of twenty acres or less may have materials available for baling and storing for winter use but until now this has usually been impractical because of machinery costs. Here is a hand-powered baler that can be built with very little cost involved.

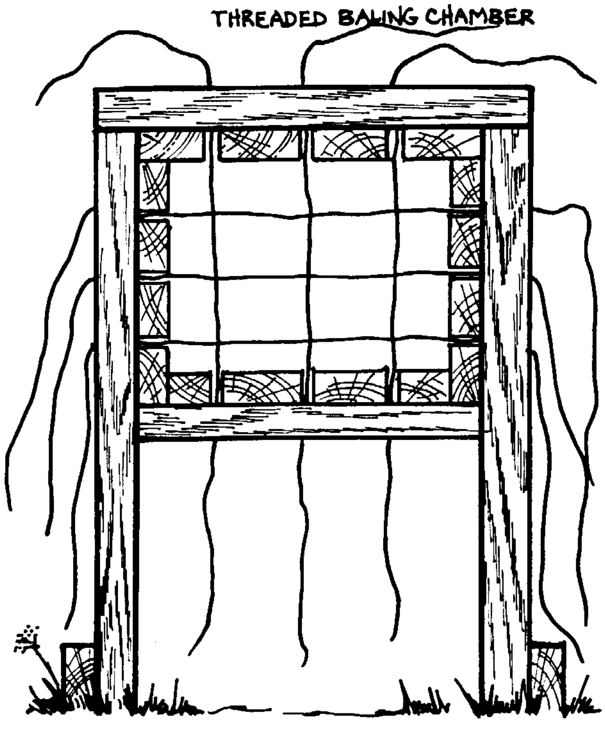
To build the baler begin by making the basic crate shape. This is done by constructing the sides, top, and bottom first. Next fasten these together to form the crate shape. All joints should be fastened with a waterproof glue and galvanized nails. The piston is put together the same way and care should be taken to make sure the spaces on the piston line up with the slots in the baling chamber. There are slots indicated on the top and bottom blocks of the piston. This is for a board, cut to fit, which is used while compressing materials into a bale. This piston face is removed when tying the bale together. All of the pivot points are put together with aluminum conduit, washers, and cotter pins. The entire machine should be painted with a good exterior paint.

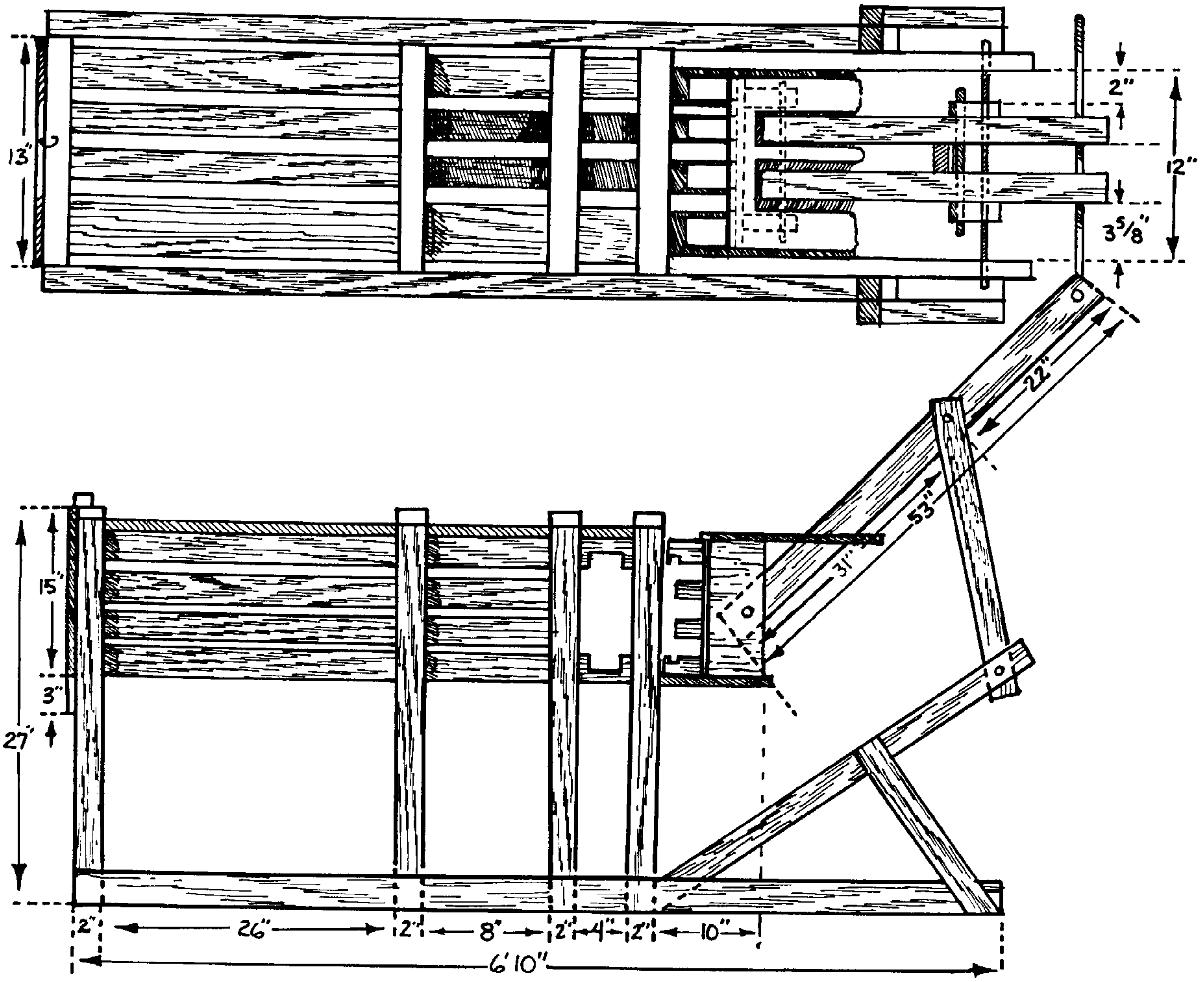
This baler will make a bale about one foot square and two feet long. Most small homesteads don't use a full sized bale at one time and the hay which is usually left over is more than likely wasted. Anyway, I just don't want to lift a ninety pound bale when I don't have to. If a machine is needed which will make a larger bale just change the size of the whole thing to suit your needs. The levers which operate the piston should remain the same because they just move the piston. Only the size and length of the chambers need to be changed along with the size of the piston. This machine can also be made out of metal. Just use the plans as a guide for sizes and operative portions.

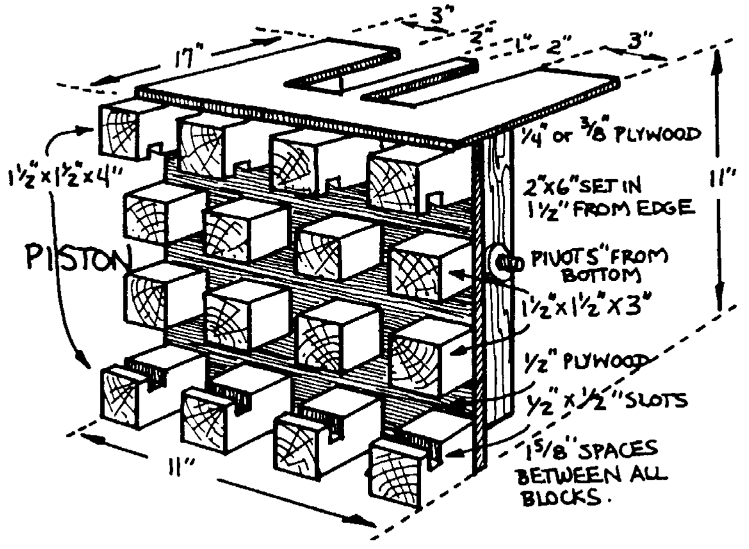
Now to operate this baler you have to first decide what you want to bale. In the summer it will probably be hay or straw. Don't quit there, the fall provides a lot of dry leaves which are excellent for livestock bedding and feed and lots of leaves can give you a great mulch the following summer in your garden. Likewise you can bale crops like comfrey provided it is thoroughly dry.



To begin the baling operation thread the baling chamber with pieces of twine or cord which has a test strength of sixty to one hundred pounds. Each piece should be about six feet long and should be threaded through the slots in baling chamber as shown. You can make a small saw kerf at the end of each slot to hold the twine. Close the baling chamber and insert the piston face plate through the side at the place indicated. If you're baling hay you're ready to go. If it's leave you need to put a piece of newspaper in front of the piston face and push it into the chamber first. Now fill the loading chamber with material and push it into the baling chamber with the piston. Repeat until you have a fully compressed bale in the baling chamber. Remove the piston face plate by pulling it out the side. If it's leaves you're baling you need to insert another piece of newspaper at this point. This is not necessary with the hay. Now push the piston in as far as it will go. Using a stiff piece of wire with a small hook formed at one end pull the twine through the slot of the baling chamber right in front of the piston. Tie off that piece and repeat with the rest of the threads of twine until they are all tied. Then drop the door and push the bale out of the chamber with the piston. Now you can grab the bale and remove it from the chamber and you're finished. It may sound complicated but one man can make a bale in about six minutes from start to finish. It goes faster if there are two people working at it. One person can load while the other operates the piston.




13"
2"
12"
3⅝"
15"
3"
27"
22"
53"
31"
2"
26"
2"
8"
2"
4"
2"
10"
6'10"


17"
3"
2"
1"
2"
3"
¼" or ⅜" PLYWOOD
11"
2"x6" SET IN 1½" FROM EDGE
PIVOTS" FROM BOTTOM
1½"x1½"x4"
PISTON
1½"x1½"x3"
½" PLYWOOD
½"x½" SLOTS
1⅝" SPACES BETWEEN ALL BLOCKS.
11"

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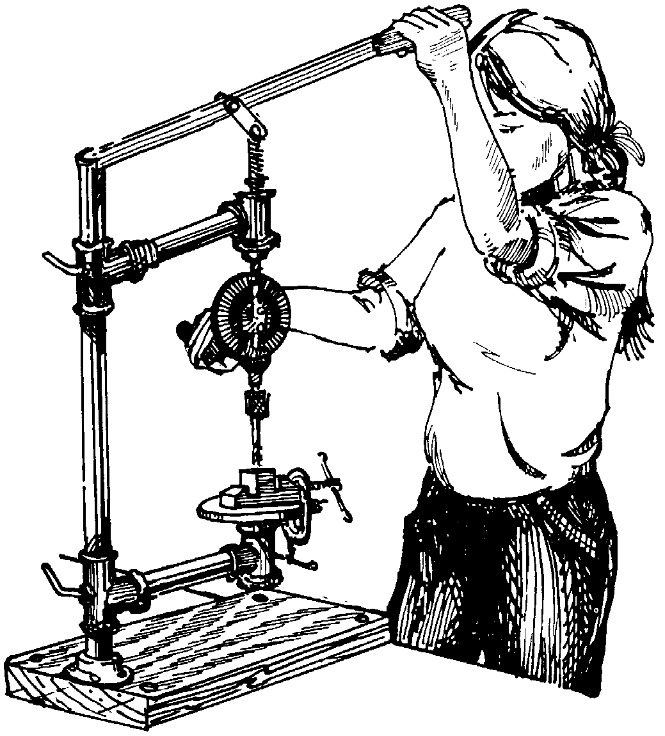
A Hand Operated Drill Press

by Arthur Howe



There's no need to place work on the floor or climb up on the bench to put enough pressure on the drill if you have a hand-operated drill press. This particular one, Fig. 1, is made from a ½ inch, 2-speed breast drill, although other sizes may be substituted. Either wood or metal is used for the base. The column is a 36 inch length of 1½ inch pipe. One end is threaded for a floor flange and the other end is notched for the operating lever. The pipe should be dressed so the two tees will be a smooth fit. These tees are reamed also and the backs are drilled and tapped for a ½ inch thread. Nuts are brazed in place in the following manner: thread them onto ½ inch bolts and turn the bolts into the tees until the nuts are flush against the tees. Then braze and remove the bolts. This will align the threads. Bend and thread short lengths of rod to make the adjusting screws.

The drill-press table is assembled as shown in Fig. 2 A short length of 1½ inch pipe is screwed to the tee on the column and an identical tee is fastened to the free end. A short nipple screws to this tee and connects to a floor flange and the table. For the upper assembly, bush the tee down for ¾ inch pipe. The nipple and tee here should centre over the drill-press table. The upper left-hand detail shows how the ¾ inch tee is assembled with the 5/8 inch rod. If you have a drill with a removable handle, you may be able to insert the rod and lock it with a setscrew, or you may have to braze it to the drill. The lever is a length of flat iron with a wooden handle riveted on. A linkage connecting the lever to the rod is held with locked nuts and washers. Fig. 3 shows an easy way to make a foot-feed drill.

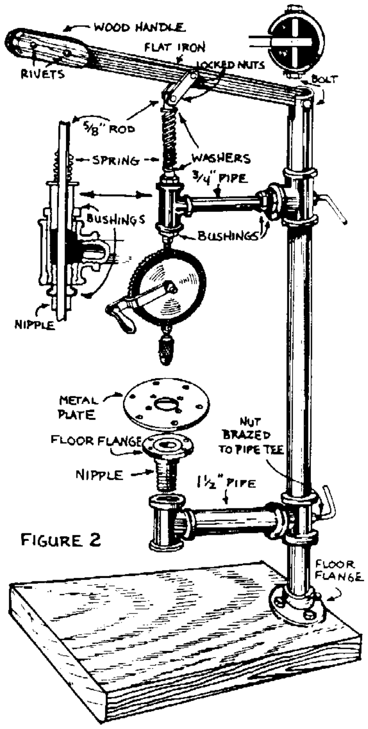


FIGURE 2

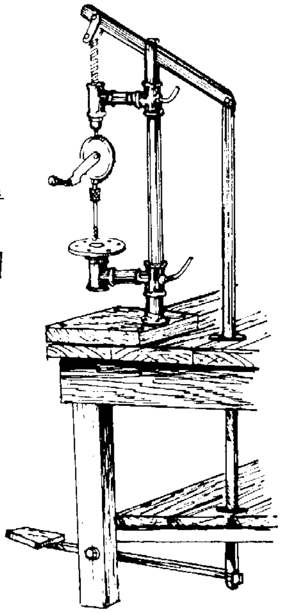


FIGURE 3

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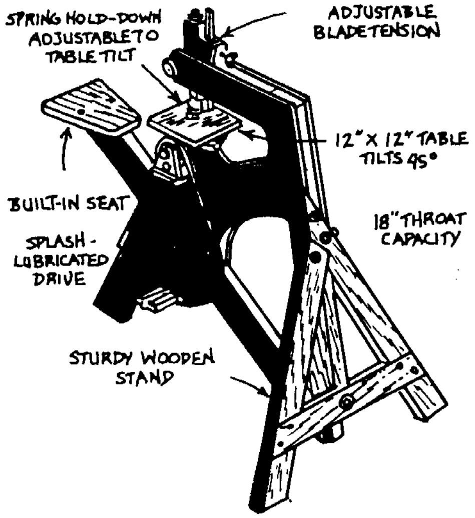
A Foot Powered Scroll Saw

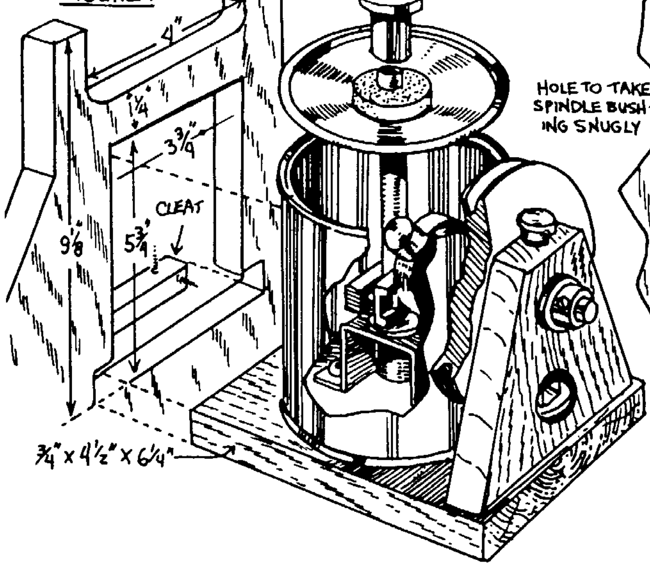
by Wayne Lecky



Aside from the bolts and bushings required, this scroll saw can be constructed mostly of wood. The few other pieces of metal needed can be salvaged, in most cases, from odds and ends found in the junk box. If you prefer not to use plywood, you can use solid stock by gluing up panels of sufficient width. The crankshaft mechanism of the drive head operates in a bath of oil and is sealed inside an ordinary 1 qt. paint can of the type having a press-fit lid. Fig. 4 will give you an ide of how it works. A crankshaft, entering the side of the can, engages a bar, which slides back and forth in a channel clamped to a vertical shaft. This produces a smooth reciprocating motion of the shaft much like a piston, the stroke being 1 in. Oil in the bottom of the can is splashed by the crankshaft to keep the mechanism well lubricated.

The complete drive unit is shown in fig. 1, partly cutaway so that you can get a better idea of its assembly. Bronze bushings are used as sleeves for the vertical shaft and also as a bearing for the crankshaft. Fig. 3 shows how the channel is clamped to flattened places on the shaft, and how the lower bushing is mounted in a flatiron bracket. Note from fig. 4 that the bolts in the latter fasten both it and the can to the wooden base. You can work the channel to shape by hand using a hacksaw, chisel and file, or you can have the channel and crankshaft made. Thick felt washers prevent leakage of oil at points where the two shafts pass through the can. The oil level, of course, should be kept below the hole in the side of the can, as shown in fig. 4. It is important that the block holding the crankshaft bearing be rigid. Fig. 2 shows a way of bolting this, which allows it to be retightened easily if it should work loose. When installing the crankshaft there must be no end play, as the face of the disk, bearing slightly against the channel, keeps the bar engaged in the latter. It also prevents twisting of the shaft and saw blade, which would cause the latter to break. So, see that the setscrews in the pulley and the

FIGURE 1



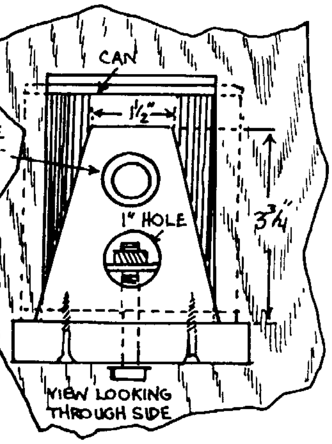

CAN
HOLE TO TAKE SPINDLE BUSHING SNUGLY
1½"
1" HOLE
3¼"
VIEW LOOKING THROUGH SIDE

FIGURE 2

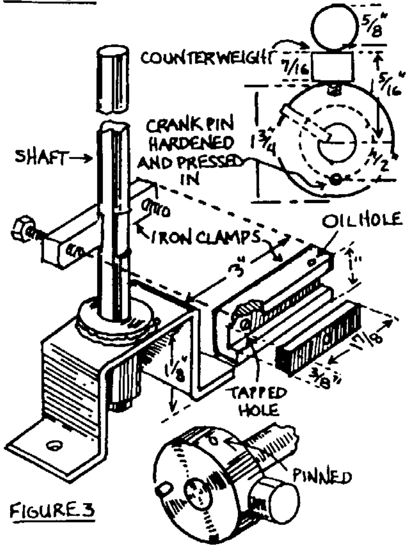


FIGURE 3

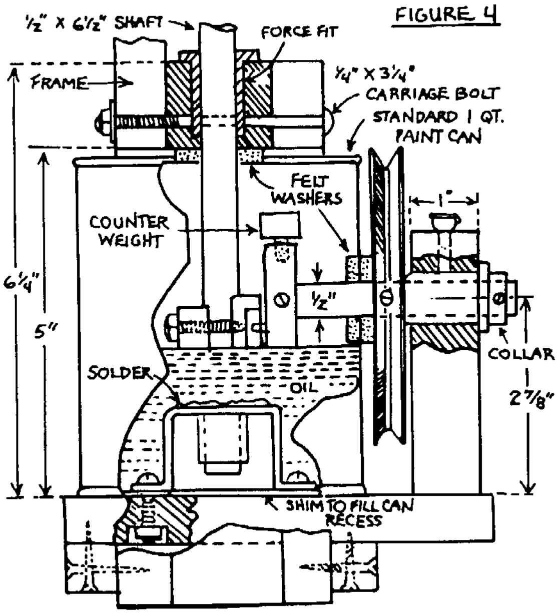


FIGURE 4

collar are tightened securely to the shaft on each side of the bushing, without side play. If desired, you can make the pulley of wood and pin it to the shaft. Before the lid can be pressed on the can, the upper end of the shaft must be threaded and slotted, so that a blade chuck like the one detailed in fig. 7 can be fitted to it after the upper bushing and the filler block in which it fits, have been slipped over the end.

You can set the drive-head unit aside for the time being, and proceed to make the wood stand. Plywood is preferred but solid stock can be used. Fig. 9 shows how both side pieces can be laid out economically on a panel, after which the two can be cut apart roughly with a compass saw and then trimmed to exact size. The size of the opening in which the drive head fits is given in fig. 1. Note that the left-hand side has projections above the opening, which serve as stops for the tilting table. The frame or core to which the side pieces are glued and bolted is made up of common 2 by 4 in. material. Fig. 6 shows the arrangement of the pieces, while figs. 5 and 8 detail how the rear legs are fastened rigidly with bolts and screws. The member which extends to form a seat is bolted to the front and rear legs in the same way as used in the drive head. As individual leg reach varies, the length of this piece will have to be determined by trial. This is likewise true in locating the bearing hole for the large drive pulley. For some persons it may be satisfactory if centred in the seat member as in fig. 8; for others it may be necessary to fit an extra block as indicated to permit lowering the position of the pulley to a point where it is easy to pedal.

Assemble the stand as far as shown in fig. 6 and then slip the drive unit into the opening provided for it before putting the opposite plywood side on the frame. This, of course, will necessitate removing the pulley and the wood bearing block. In doing this, be careful that the pin in the crankshaft does not disengage the bar. Cleats are used in the manner shown in figs. 1 and 4 to fasten the drive unit in place, after which the filler block containing the upper bushing of the shaft is bolted flush with the top of the plywood sides. With this filler block in place, you

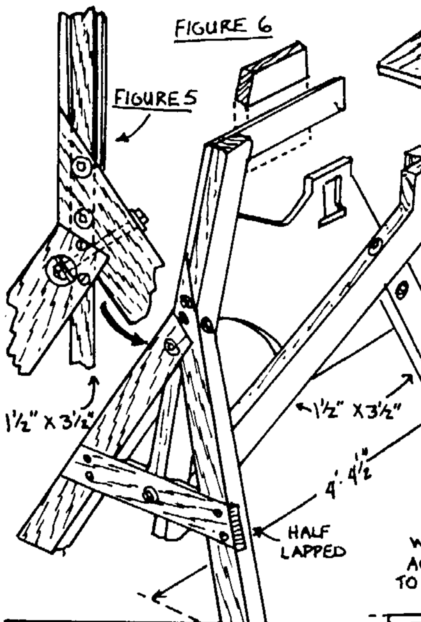


FIGURE 6

FIGURE 5

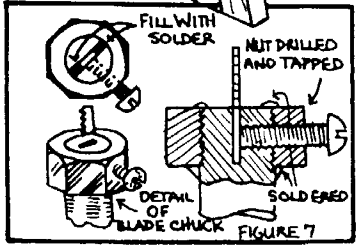


FIGURE 7

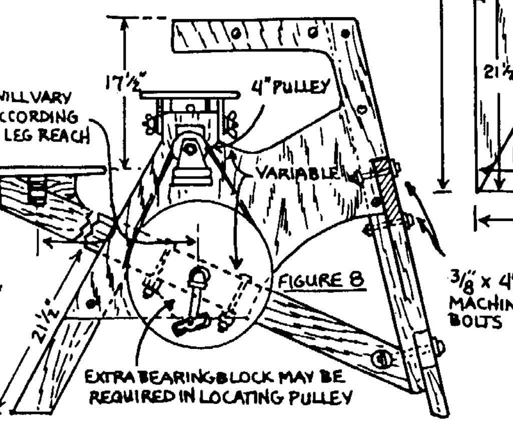


FIGURE 8
WILL VARY ACCORDING TO LEG REACH
17½"
4" PULLEY
VARIABLE
29"
21½"
⅜" x 4" MACHINE BOLTS
EXTRA BEARING BLOCK MAY BE REQUIRED IN LOCATING PULLEY

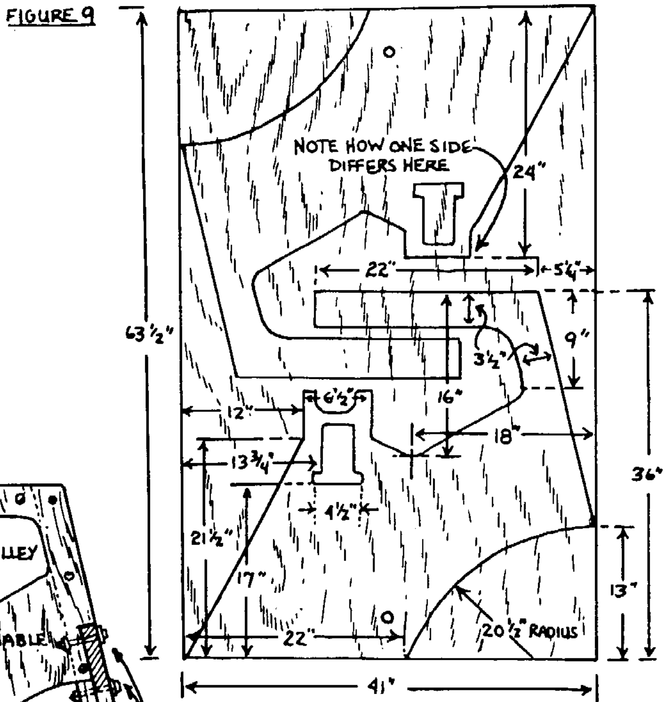


FIGURE 9

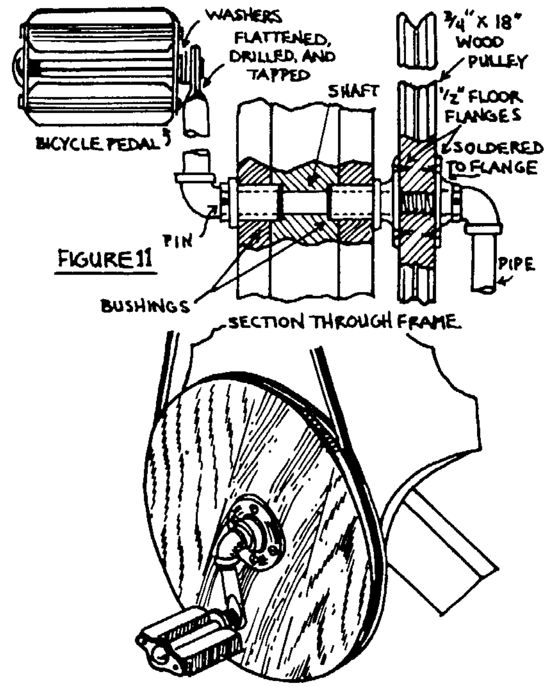


FIGURE 11

can go ahead and add the blade chuck to the slotted end of the shaft. This consists of a hexagon nut screwed and soldered to the end and then drilled and tapped crosswise for a setscrew to clamp the blade as shown in fig. 7. The blade can be made self-centreing in the chuck by filling the slot with solder on each side of a piece of wood that is the same width as the blade.

The sectional view in fig. 11 shows how the large drive pulley is held to a ½ in. pipe shaft by two floor flanges which are centred and screwed opposite each other. One end of the shaft is threaded to pass through the flanges far enough to permit a ½ in. elbow to be pinned to the projecting end and soldered to the flange. If you are unable to have the bushings turned of metal to fit the pipe shaft, satisfactory ones can be turned of hard maple and replaced at signs of wear. If metal bushings are used, they should be a press fit in the stand. Bicycle pedals, which can be picked up at a repair shop, attached to flattened ends of short pipe arms make a neat job. Owing to the size of the plywood drive pulley, you'll have to true it on the outer end of the lathe.

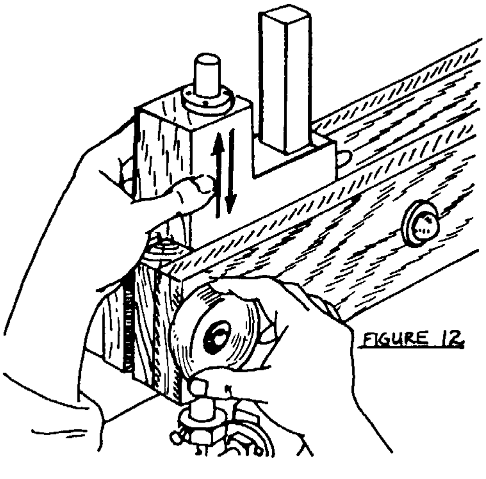


FIGURE 12

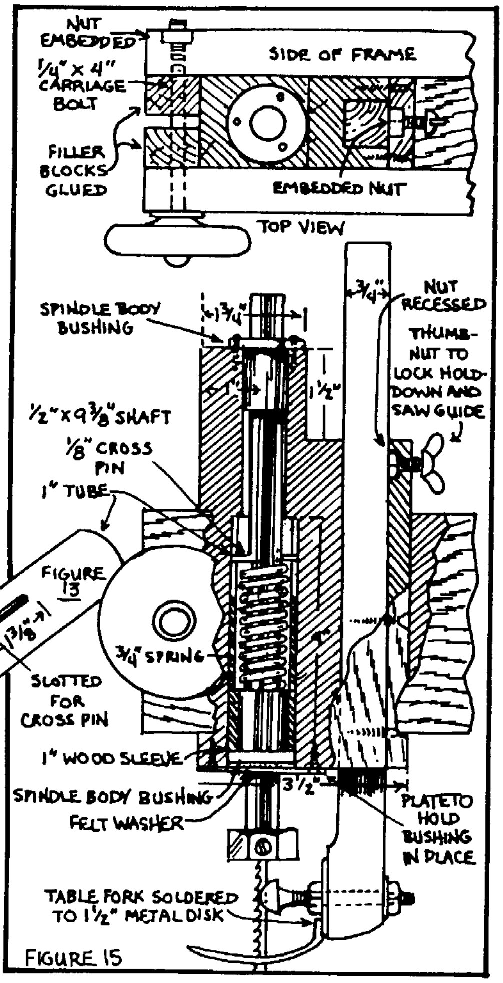


FIGURE 15

You make the blade-tension unit, fig. 12, next. This is adjustable up and down in the arm so that the tension on the blade can be varied to suit the size being used and thereby reduce breakage. A record of the tension found best for each blade can be indicated on the side of the unit by marking on it across the top of the frame. These calibrations will tell you how much to raise or lower the unit when changing to a finer or coarser blade. Fig. 14 gives the steps in making the wooden housing of the unit. You begin with a hardwood block 1½ by 3 by 7 in. A line is drawn down one side and across both ends to mark the points for boring. As it is important that the holes be in

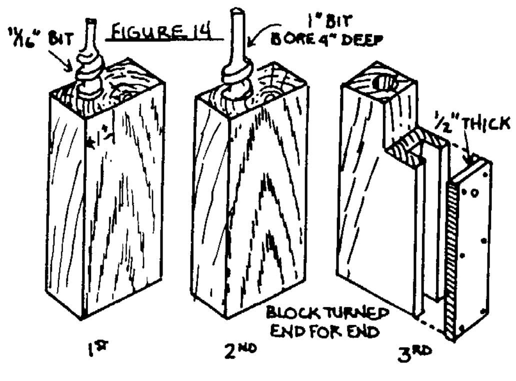


FIGURE 14

line centrally through the block, a drill press is preferred to boring them by hand, although the latter can be done fairly accurately if you are careful to keep the bit running as straight as possible. Bore the top hole 3 in. deep, then turn the block end for end, and with a 1 in. bit, bore through to meet the first hole. Next, groove the rear edge of the block to take the hold-down, after which the upper corner is notched according to the dimensions given in fig. 15.

The cutaway sectional view in fig. 15 shows what the tension mechanism looks like when installed in the counterbored housing. Bronze bushings of the type that were used in the drive head are used here to carry the shaft; the upper bushing being pinned to the block through the flange and the lower one bushed centrally in the hole with a turned wooden sleeve. Fitting the lower bushing is done after the large hole is lined with a 1 by 2¾ in metal or Bakelite tube, slotted like the one shown in fig. 13. This tube, besides forming a well for grease to lubricate the spring and lower bushing, keeps the shaft tracking without twist by engaging a cross pin in the shaft in slots in the tube. Needless to say, the slots in the tube must be cut down each side exactly in the centre, otherwise the pin is apt to bind or prevent assembly. The shaft, with the cross pin either threaded or pressed into it, must be slipped inside the tube and both inserted in the hole at the same time, after which the spring is added and the lower bushing and its sleeve are pressed in the end to hold the tube in place. The width of the slots in the tube should equal the diameter of the cross pin. Note that a thick felt washer is provided between the bushing and the metal plate which holds the former in place, to prevent oil from being thrown out through the shaft clearance in the plate. The upper blade chuck is made the same way as the lower one, which was described previously, the end of the shaft being threaded for the nut before the shaft is installed in the housing.

A turn of a handwheel clamps the unit securely in the arm. This can be made of wood and fitted with a carriage bolt to engage an embedded nut in the opposite side as shown in the top view of fig. 15. The completed unit must be mounted in the arm so that the upper chuck will be directly in line with the lower one. You can do this best by clamping the unit temporarily in place with a C-clamp or a handscrew and checking it for alignment with a square held along the underside of the arm. When centred, the frame core piece along the top of the arm is fitted and bolted in place behind the unit and filler blocks or stops are glued between the sides at the front. See top view, fig. 15.

The work hold-down, figs. 15 and 16, is improvised from an old table fork having the two centre tines removed.

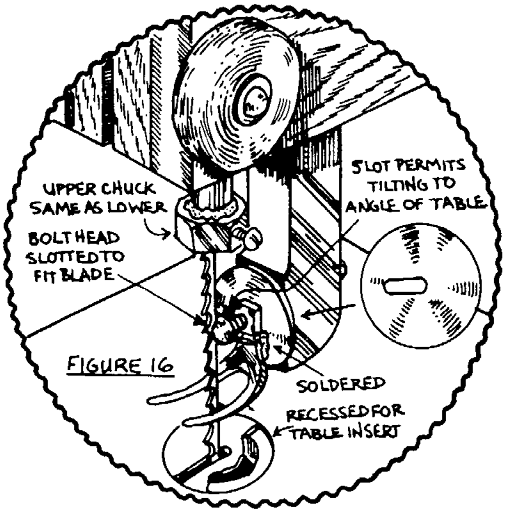


FIGURE 16
UPPER CHUCK SAME AS LOWER
BOLT HEAD SLOTTED TO FIT BLADE
SLOT PERMITS TILTING TO ANGLE OF TABLE
SOLDERED
RECESSED FOR TABLE INSERT

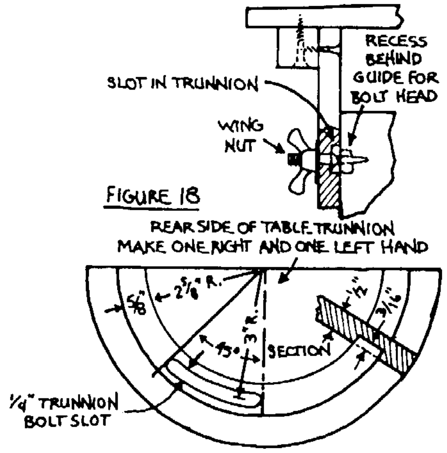


FIGURE 18
SLOT IN TRUNNION
RECESS BEHIND GUIDE FOR BOLT HEAD
WING NUT
REAR SIDE OF TABLE TRUNNION MAKE ONE RIGHT AND ONE LEFT HAND
5/8"
2 5/8" R.
3" R.
45°
SECTION
1/2"
3/16"
1/4" TRUNNION BOLT SLOT

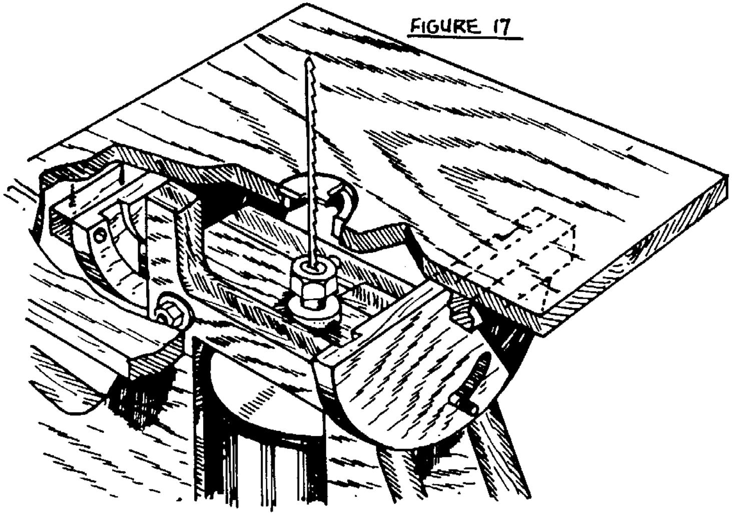
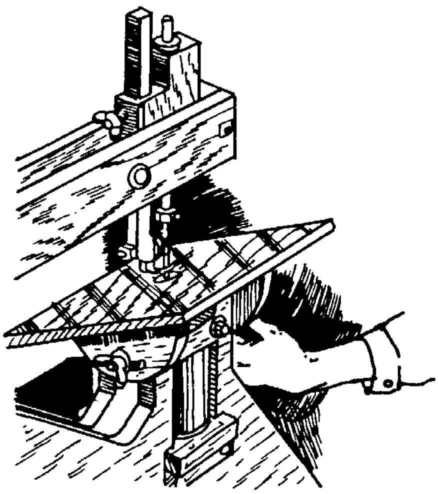


FIGURE 17

It is soldered to a 1½ in. disk slotted crosswise, to permit the hold-down to be adjusted to whatever slant the table may be tilted. The fork and disk are held to a wood shaft by a bolt blade guide. Several of these guides will be needed to accommodate blades of various thicknesses. You can make them easily from ¼ in. carriage bolts by slotting the heads the required depth with a hacksaw and then closing the slot slightly by peening it to suit the blade thickness. A thumbnut fitted as shown in fig. 15 serves to lock the hold-down at the desired height, and wax applied to both the shaft and the channel in which it moves will make it slide easily.

Making the **trunnions** for the tilting table will require the use of a lathe, as a groove must be turned in them to take guides on which they move. Both trunnions can be had from one plywood disk by sawing it carefully in half after turning to size. Note in fig. 18 that the bolt slots through the trunnions must be cut on opposite sides of the centreline to obtain right and left-hand units. Use hard-pressed board from which to turn a ring to fit the trunnion grooves nicely and then screw 3 in. segments of the ring flush with the top of the frame at the front and back as shown in figs. 19 and 20. Notice that the square heads of the trunnion bolts are embedded under the guides before screwing the latter in place. A wing nut and washer are provided on each bolt to lock the trunnions in position. Wax applied to the trunnion grooves and the guides will make the table tilt smoothly. Plywood is preferred to solid stock for the table, as it will stay flat. It is attached to the trunnions with cleats as shown in the upper detail in fig. 18. You will have to do this, of course, while the trunnions are in place on the guides. The recess for the metal table insert is formed easily by pressing a turned ring in the hole as shown in fig. 17. Here you can also see how the frame extensions provide stops to permit returning the table quickly to a horizontal position. Where it is desired to have the table so it can be tilted 45 degrees to the left also, the stops can be cut off. With this arrangement, the clamping-bolt slots are extended and the trunnion indexed 90 degrees for rapid setting.

If you are unable to buy an endless V-belt long enough to reach the drive pulley, you can resort to round leather belting or even sash cord, applying belt dressing if slippage develops.



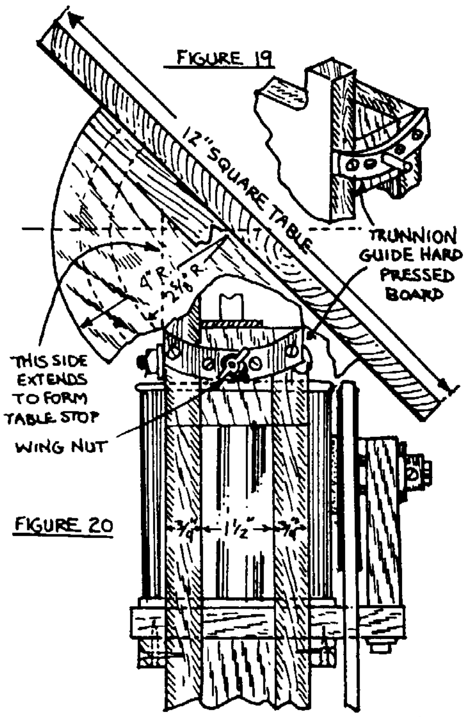


FIGURE 19

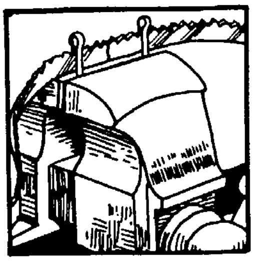
FIGURE 20

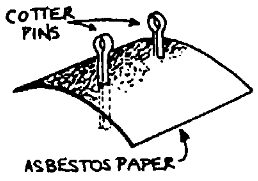
12" SQUARE TABLE
TRUNNION GUIDE HARD-PRESSED BOARD
4" R.
2⅛" R.
THIS SIDE EXTENDS TO FORM TABLE STOP
WING NUT
¾"
1½"
¾"

FRONT VIEW SHOWING TABLE TILTING TRUNNION

Cotter Pins Hold Bandsaw Blade in Vise While Brazing

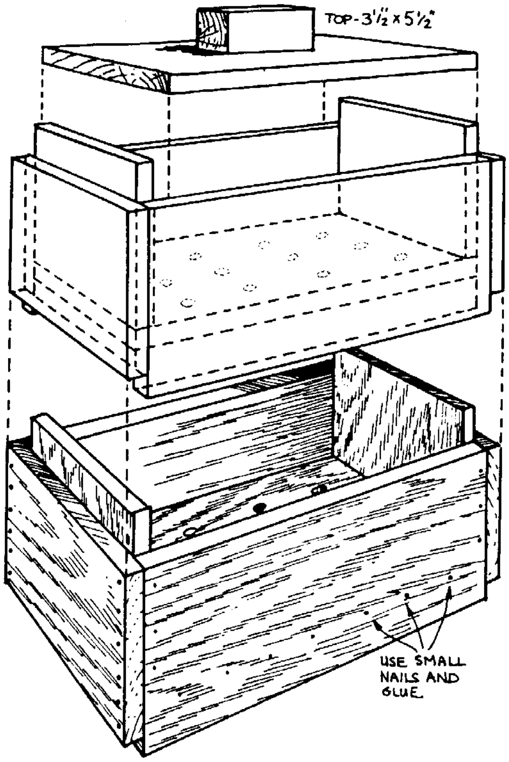
Instead of making up a special jig to hold the ends of broken bandsaw blades in perfect alignment while brazing, just slip a couple of cotter pins over the blade and clamp them in a vise as shown. To protect vise jaws against excessive heat from the torch, a piece of asbestos paper can be held in place under the blade by forcing both cotter pins through the centre of the paper before clamping them in the vise.





Sprouting Trays

by Larry McWilliams



© 1974 by Larry McWilliams

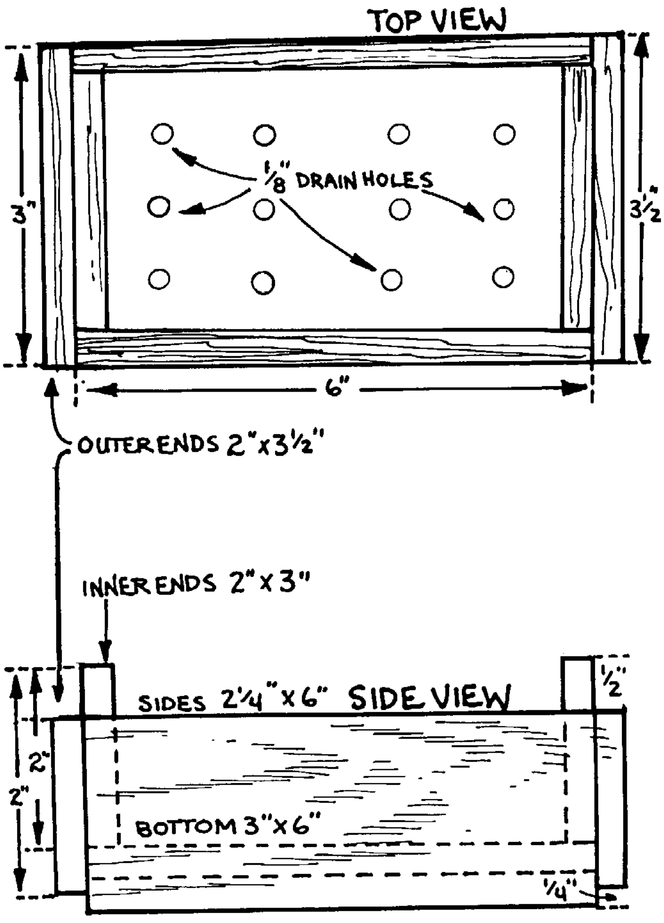
There's a lot of interest in sprouting devices for livestock and feed and a request came through for a simple but effectively designed system for stacked sprouting trays. The ones shown here will stack as tall as is practical for your own situation and will provide excellent drainage. There is no need for a special tray for the bottom since all the trays can be used as a bottom tray.

To make the trays use ¼ inch plywood and cut the parts as shown. The only point I might make is that you might taper the top ½ inch of the inner end pieces slightly. This will assure an easy fit after painting. After you have all of the parts cut for as many trays as you want and the one for the top, you can assemble them.

To do this put together the inner ends and the sides. You should use a good glue and small nails for the construction. After the inner ends and sides are put together put on the bottoms. Next you can attach the other ends. For a handle on the top, any type can be used from a thread spool to a regular handle or a simple block of wood.

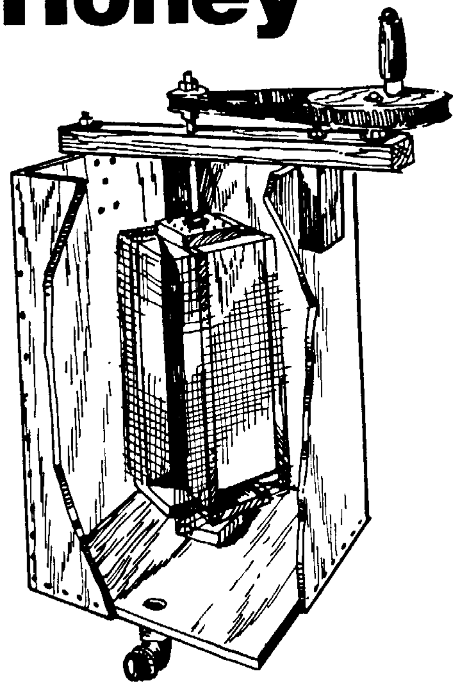
After drilling your drainage holes in each tray, you then need to completely paint the trays. Since they are going to be used in constant connection with water, you should use a good waterproof paint. Do not use a lead-based paint, as the lead is toxic. My recommendations would be a good epoxy-type paint.

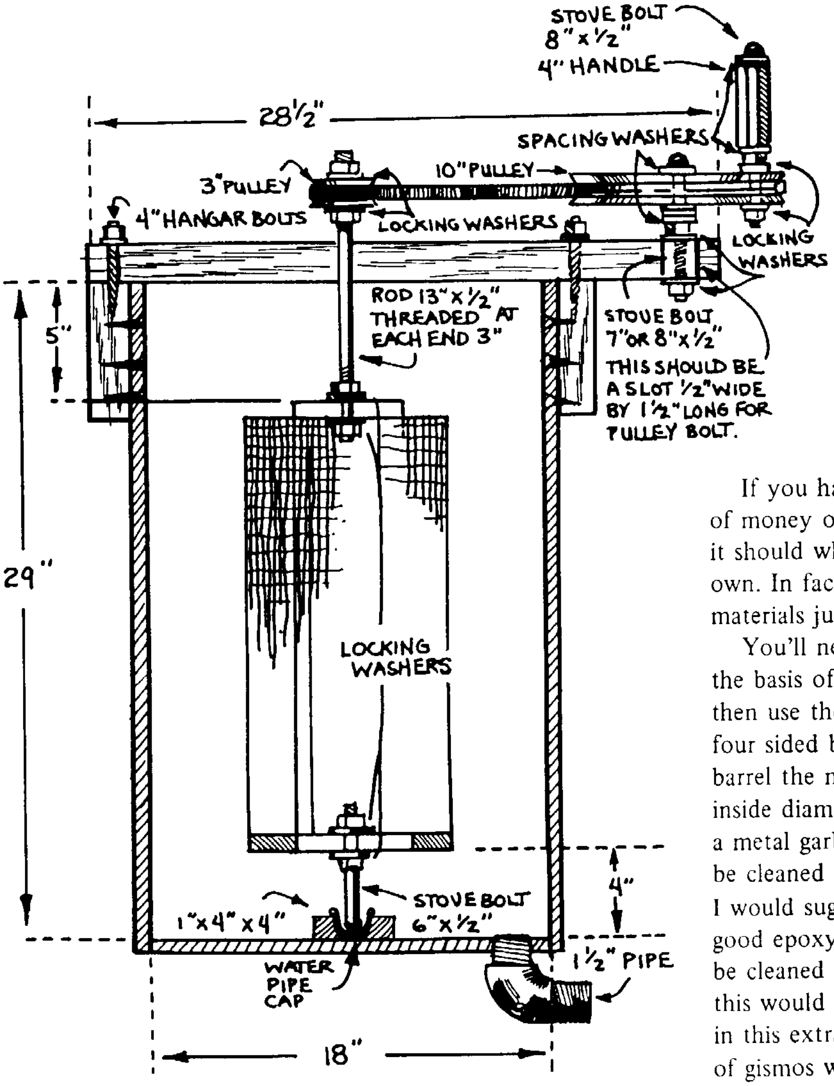
You will probably want to make five or six trays for each stack. Remember that it is easier to make several of these trays at one time than it is to make a few now and then have to make more later. I won't try to tell you about sprouting or its virtues here, but I would like to say that I've tried it and the results are fantastic to say the least. So if you haven't tried sprouting, build these trays and join us in some great eating.



A Homemade Honey Extractor

by Larry McWilliams





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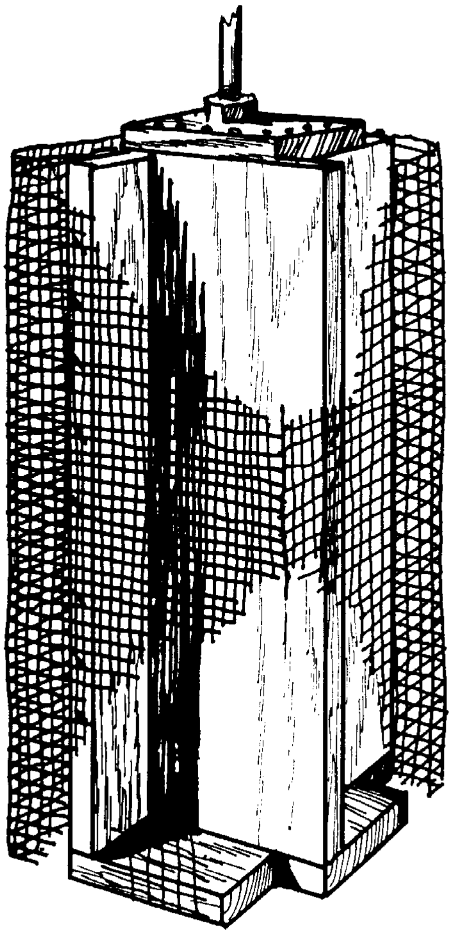
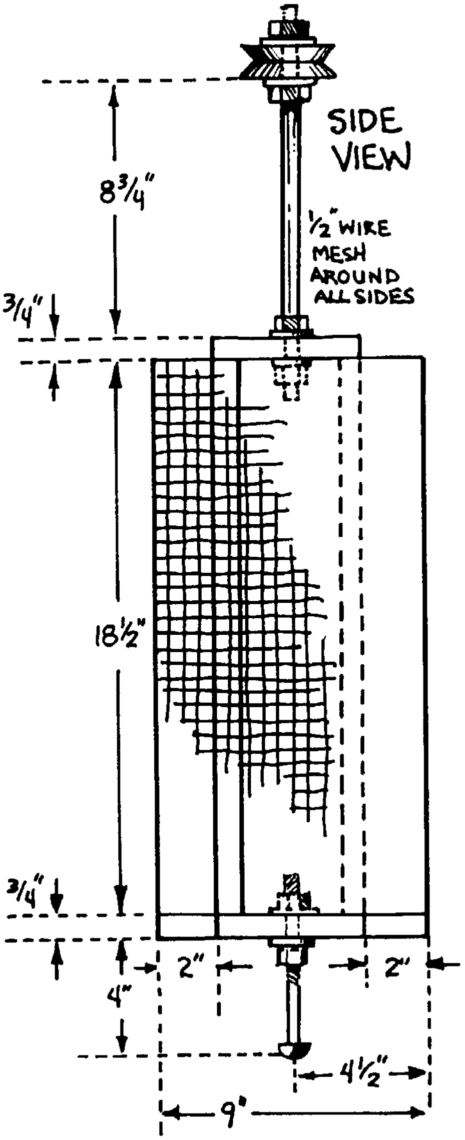
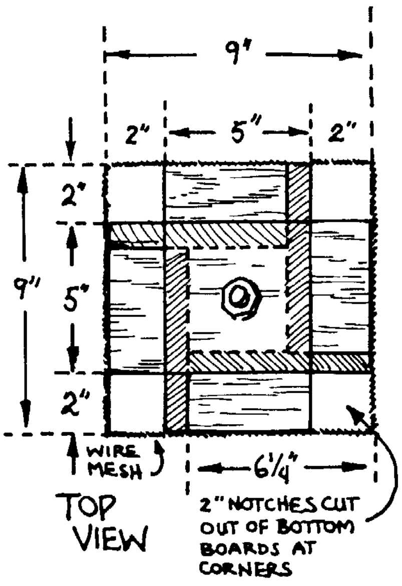
If you have only two or three hives then spending a lot of money on a honey extractor may seem ridiculous and so it should when for just a few dollars you can build your own. In fact most homesteads probably have the required materials just lying around waiting to be put to a good use.

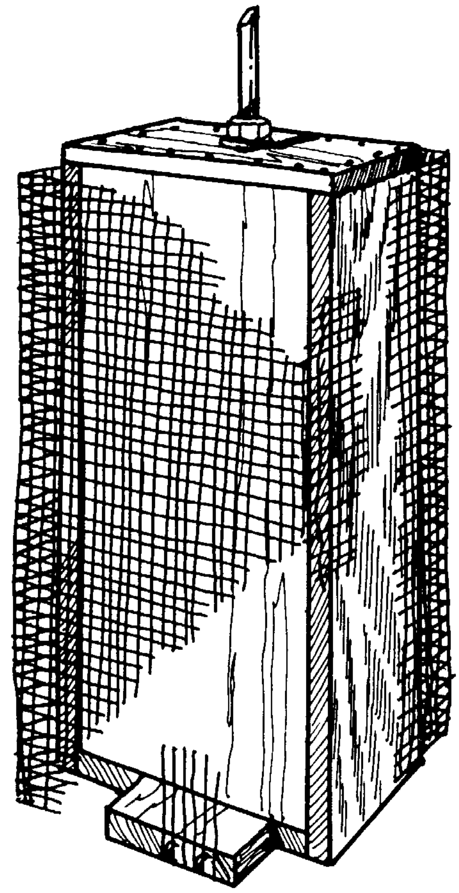
You'll need some kind of large barrel or tank to use for the basis of this whole operation. If you don't have one then use the method shown in the sketches which is just a four sided box made of plywood. If you use a drum or barrel the minimum size should be 29 inches high with an inside diameter of at least 18 inches. You may even find a metal garbage can of that size. Whatever you use it should be cleaned thoroughly and if you use wood or bare metal I would suggest you paint it with two or three coats of good epoxy paint inside. Since the whole extractor should be cleaned thoroughly with hot soapy water after each use, this would give a very duable coating. The bushings used in this extractor are very basic. You can purchase all types of gismos which will substitute for the ones shown. This design is for someone who wants to keep the cost down and still end up with a good machine. The pulleys can also be purchased but two pieces of plywood cut in a circle at an angle of about 45 degrees then glued and screwed together will make a pulley just as well.

The baskets which hold the frames for extracting are very simple and easy to make. You can make both baskets or just the one that you would need the most. The parts of the baskets should be glued and screwed together and then finished with epoxy paint. The wire mesh can be stapled or nailed to the wood. The wire should be only on the sides. Leave the bottoms open so the ends of the frames will fit into them where the holes are located. The sketches will do a better job of explaining the actual construction than I can put into words. Even if you buy all of your materials you should be able to put it together for $20 to $25. But then again materials may cost more than that by the time this article is printed. Enjoy your sweet tooth.

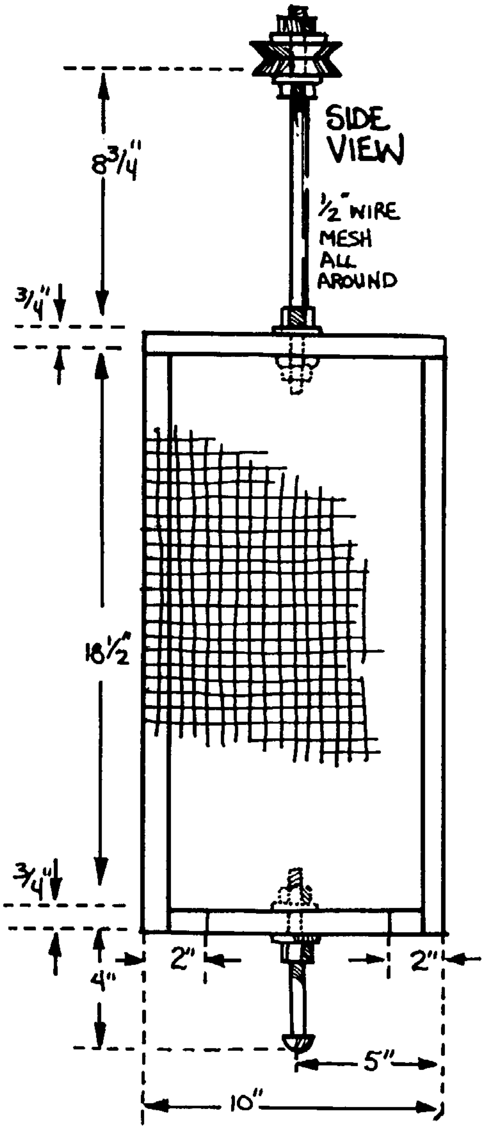

BASKET FOR SHALLOW SUPER'S FRAMES

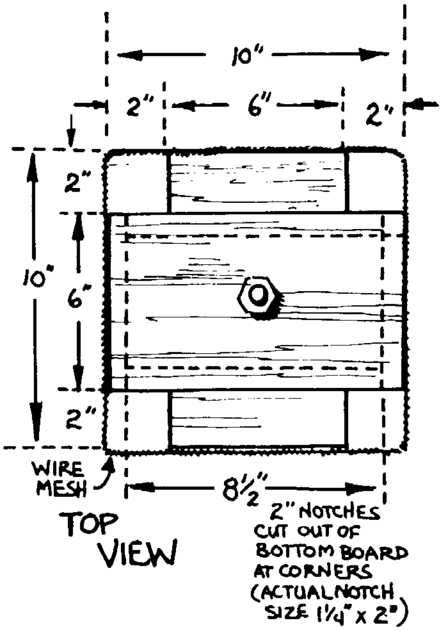

SIDE VIEW


TOP VIEW



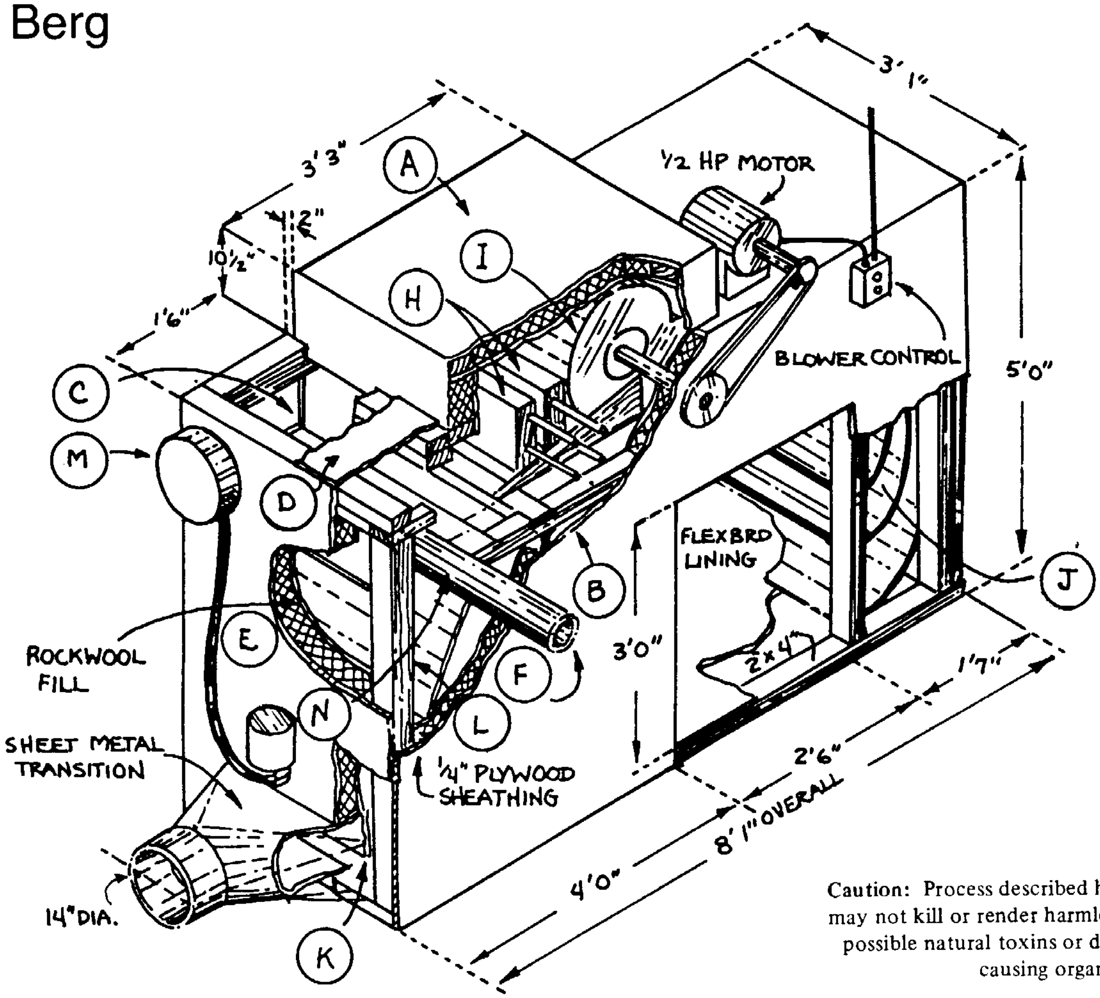
BASKET FOR DEEP SUPER'S FRAMES




10"
2"
6"
2"
2"
10"
6"
2"
WIRE MESH
8½"
TOP VIEW
2" NOTCHES CUT OUT OF BOTTOM BOARD AT CORNERS (ACTUAL NOTCH SIZE 1¼" x 2")

A Controlled Smokehouse

by Iola Berg



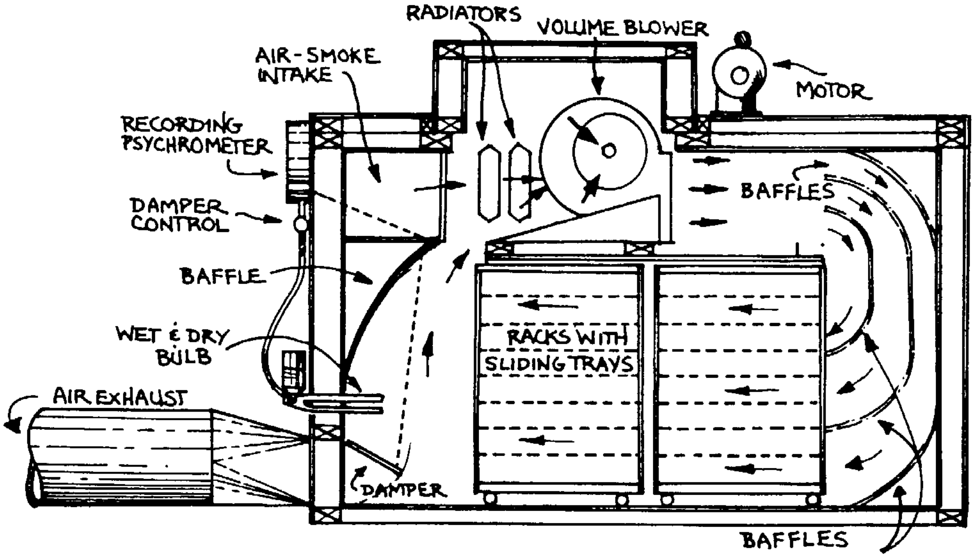
Caution: Process described herein may not kill or render harmless all possible natural toxins or disease causing organisms.

This unit was approximately 8 feet long, 6 feet high and 3 feet wide. The box (A) situated above and fitted tightly into the main housing is removable and necessary only to enclose the volume blower and to allow access to the blower and radiator heating units. Lots of from 150 to 250 pounds of fish can be cured in this smokehouse.

The framework is of 2 inch x 4 inch lumber with an inner lining of 1/8 inch flexboard (cement-asbestos) and an outer covering of 1/4-inch plywood. Rock wool is used for insulation. Flexboard was used for the inner lining since this material will not corrode and may be easily cleaned. A section of flexboard (B) was installed to divide the smokehouse into two sections; that is, to separate the radiators and blowers from the smoke chamber itself. This merely completes and separates the smoking chamber to permit accurate control during the smoking process.

Air enters the house proper through a square hole (C) as indicated in figure 1 and may be seen in figure 2. The air intake is controlled by a sliding panel (D) that fits snugly over the opening. The air intake leads into a long box (E), which extends horizontally across the house and acts as a mixing chamber for the smoke and air. Smoke enters this box at the opposite end from the air intake at the point (F). This box has an opening near the centre, and facing the radiator heaters (H). The air-smoke mixture is drawn through this opening by the blower (I) and is simultaneously mixed and heated. The heaters are two steam radiators of the "colonial wall" type, held in position by ordinary "U" bolts supported from angle irons. These angle irons rest on the framework proper. The temperature of the radiators is controlled by a thermostat connected to a magnetic steam valve on a by-pass steam line.

The smoke is distributed through the smoking trays on the racks located in the smoking chamber by means of the volume blower and the baffle arrangement (J). The particular blower used has a capacity of 2100 to 2750 cubic feet per minute and is operated by a 1/2 h.p. electric motor. The smoke, after being deflected by the baffles, is either exhausted through the outlet damper (K) or is recirculated back through the radiators and blower after being deflected

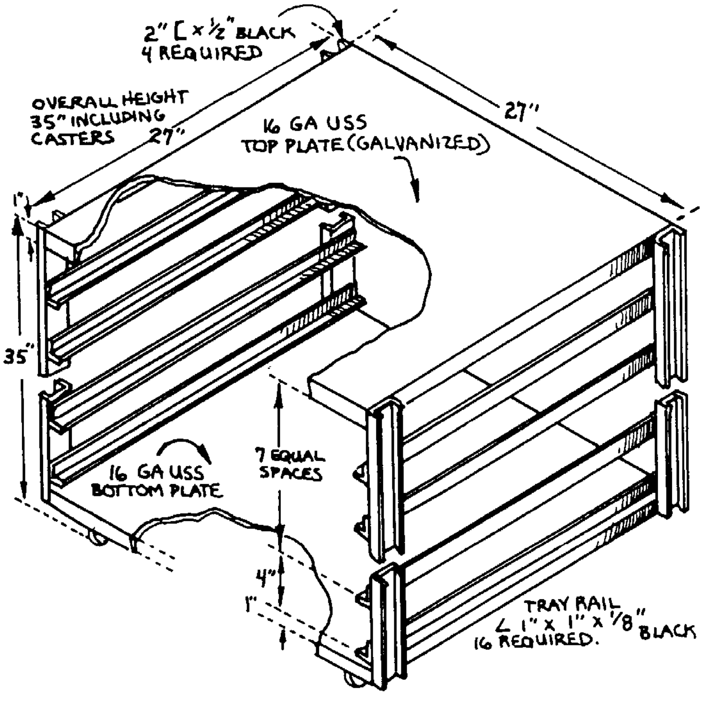


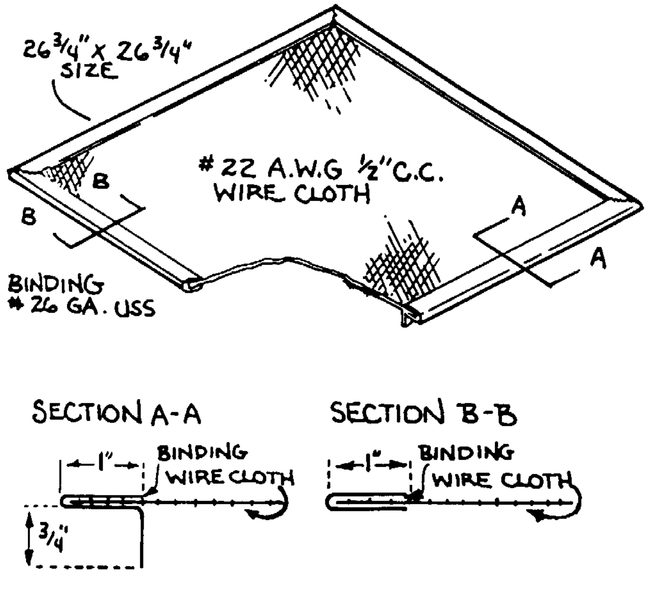
by baffle (L). A sectional view of this arrangement and the direction of air-smoke flow may be seen in figure 2.

The baffles are constructed of pliable light metal sheeting. Considerable manipulation was necessary to locate the exact position of the baffles in order to insure a uniform air distribution. This is accomplished by hanging long narrow strips of cloth across the direction of air flow in the smokehouse chamber. Several sets of these strips placed parallel to each other are set up. When the air blower is turned on, the baffles are then adjusted until uniform deflection of the cloth strips is obtained. The upper portion or inlet of the baffle is spaced evenly and is stationary, while only the lower portions are adjustable. As an aid to obtaining proper circulation in this type of unit, the area of the blower outlet, the air intake, and the air exhaust should be of equal dimensions.

A recording psychrometer (M) was installed to the rear of of the house, with the bulbs and thermostat situated just above the damper. At this location, they are exposed to direct air circulation and are in a safe place away from the "working" parts of the smokehouse.

The smoking racks are constructed of angle iron and mounted on metal casters. These racks are of such height so as to fit flush against the top of the smokehouse chamber when in place. This is necessary to take full advantage of the entire chamber and to permit a more uniform circulation of smoke by eliminating unused spaces. These racks are equipped with a series of angle iron guides along two parallel sides for holding fish trays or rods and are so constructed as to allow 3½ to 4 inches of air space between each tray





when in place. The trays consist merely of 1/2-inch mesh screen trimmed with a light metal band to make them sturdy and durable. During the smoking process, the racks are placed in such a position that the angle iron guides run parallel to the length of the house, so as to permit an unobstructed flow of air over the trays. The racks are so designed that the trays can be easily removed and rods inserted in their place for hanging fish or fillets. The construction of the racks and trays is shown in figure 3.

The smoke generator consists of a metal oil drum placed horizontally on a metal frame. A door and draft are cut in one end; through the top part of the other end is located the smoke pipe outlet. This outlet pipe leads into a "T" pipe joint equipped with suitable dampers. One part of the "T" joint leads to the smokehouse, while the other leads to the outside atmosphere. The dampers (N) are used to direct the smoke into the smokehouse and to aid in the control of the smoke volume. When the smoking process is completed, the dampers are adjusted so that the smoke is directed to the outside atmosphere.

The smoke generator is located about 20 feet from the smokehouse proper and connected by the 5 inch pipe. In this particular case, locating the generator a great distance from the smokehouse served to minimize any fire hazard. A drain valve was located in the pipe about midway between the generator and smokehouse inlet to allow for removal of the tar and resinous material that condensed in the pipeline.

In general, this design was adopted utilizing the equipment most suitable for pilot plant operation and adaptable for commercial operations. Other individual pieces of equipment may be substituted. For this pilot plant model, steam heat was used. Suitably designed oil burner units or electric heaters may be substituted. Other minor changes could be made, depending upon the materials available in any particular location. For commercial operations the design may be altered slightly, but actually all that would need to be done would be to enlarge the dimensions and increase the unit capacities.

SMOKE CURING PROCESSES

It is emphasized that only good quality fish or shellfish should be used for smoke curing. Smoking will not cover up or conceal the poor flavour and quality of inferior fish. The strictest sanitation at all points in the procedure should be practised. Smoked fish is a perishable product and should be handled as such. Careless handling will result in a poor quality product of short keeping time. Clean utensils, as well as clean, pure salt and water, should be used in brining and washing processes.

For making up the proper brine concentrations, a salinometer should be used. If one is not available, the proper salt concentration can be prepared from the data shown in Table 1.

The smoking procedures given below are **applicable only for use with the preceding type controlled smokehouse.**

Kippered Salmon

1. Any species of salmon may be used; however, the king or chum is preferred. Commercially, the white king salmon is used almost exclusively. Dress the fish into fillets. These whole fillets may be cured, but the usual practice is to cut the fillets into approximately one-pound pieces.
2. Soak the fish for one-half to three hours in 90° to 95° salinometer brine, the length of the fish and the degree of salting or salt flavouring desired. Rinse the pieces and allow to drain slightly.
3. Arrange the fish on screens. New screens or freshly-cleaned screens should be rubbed with a cloth soaked with a vegetable oil. This "oiling" prevents the fish from sticking to the metal screens during the smoking process. Mineral oil or any good quality edible vegetable oil such as cottonseed, corn, or soya oils may be used. The thinner pieces of fillets should be segregated so that they may be removed during the smoking process, since these sections require a shorter curing time. Place the racks in the smokehouse chamber preheated to 100°F. Dry the fish for 1 to 1½ hours at 100°F, using the volume blower, and with both the intake and exhaust dampers fully open. At the end of this time, adjust the dampers to one-half open and begin the smoking operation. Maintain the temperature of 100°F and continue smoking for one hour. Raise the temperature gradually to 170°F - 175°F and smoke for an additional hour, after which time the thinner pieces of fish are removed. The thicker pieces are smoked and cooked for an additional hour at 170°F - 175°F. After this cure, the smoke is by-passed from the smokehouse, the dampers opened full, and the fish allowed to cool to room temperature. Kippered salmon may be consumed immediately or may be wrapped in cellophane and refrigerated for later use. The product is quite perishable, but for longer storage periods the fish may be quick-frozen and held in storage for later use as desired.

Cold Smoked Salmon

1. Mild-cured or hard-salted salmon is used. Soak the fish fillets for 18 to 24 hours in fresh running water. Trim off any ragged edges and drain thoroughly. Draining may be accomplished by hanging the sides on rods or by a procedure known as "water horsing" in which the fish are piled flesh side down and weighted down to press out the water.
2. After the fish have drained thoroughly, arrange the sides on the wire-mesh smoking screens which have been previously rubbed with vegetable oil. The fillets may also be strung on rods or racks. Allow sufficient space for smoke circulation.
3. The curing procedure is varied in accordance with the type of cure and degree of preservation desired. If the product is to be consumed immediately or within a short period or if it is to be quick-frozen for later use, only a light cure is desirable. For a product of good keeping quality, a longer drying and curing process is necessary.
   (a) **Light cure.** The racks are placed in the smoking chamber maintained at 85°F, with the volume blower on. With the dampers fully open, continue this drying process for 3 to 4 hours. After this time, close the

air intake damper, readjust the exhaust damper, and begin the smoking operation. Continue the smoking process for 8 to 10 hours, maintaining the temperature at 85°F or slightly lower.

(b) **Heavy cure.** Place the fish racks in the smoking chamber and dry for 2 hours at 85°F. After this time, adjust the intake and exhaust dampers to the one-third open position and begin the smoking. Smoke at 85°F for 5 to 6 days.

This type of cure produces a firm, dark brown product of reasonably good keeping quality. Refrigeration is not necessary, but is desirable if extended periods of storage are contemplated.

Hot Smoked Smelt

1. Only strictly fresh smelt should be used. Medium or large-sized fish are more suitable for smoking. The fish may be headed and eviscerated or may be left in the round. The dressed fish represent approximately 75% of the weight of the whole fish. Wash the fish thoroughly and drain slightly.
2. Soak the smelt for 45 minutes in a 60° salinometer brine. Rinse thoroughly and spread the fish on oiled wire screens and allow to drain. If desired, the round fish may be strung on rods by inserting the rod through the gills and mouth. These rods are then placed on the smoking racks.
3. Place the racks in the smoking chamber preheated to 220°F. Dry the fish for three hours at this temperature, with the intake and exhaust dampers fully open. After this time, set the dampers at the one-third open position and allow smoke to enter the smoking chamber. Gradually raise the temperature of the smokehouse to 130° to 140°F and continue the smoking process for 7 to 8 hours. In this process, the fish lose approximately 25% of their weight due to shrinkage.
4. Exhaust the smoke from the chamber and cool the fish to room temperature. The fish may be consumed immediately or packaged in cellophane and held under refrigeration for short periods of storage.

   This cure produces a very fine-flavoured product with a delicate golden brown colour. The smoked smelt may be eaten whole, inasmuch as the process is sufficient to render the bones friable, while the natural oil present prevents the fish from becoming dry and tough.

Smoke Curing Prior to Canning

Fish are smoke cured prior to canning in order to give the canned fish an additional flavouring and colouring and in many cases to improve the texture of the product. Subsequent canning and storage of smoked fishery products tend to enhance the smoke flavour and colour and for this reason the fish should not be oversmoked.

The smoked fishery products may be hermetically sealed in cans by either of two methods: by vacuum sealing or by steam exhausting and sealing. The former method is accomplished by sealing with a vacuum closing machine. In the latter process, the filled cans are first partially sealed; that is, the lids are placed in position and given the first clinch. These cans are then exposed to live steam in a steam box for 12 to 15 minutes. The steam box is merely a wooden or metal container with a loose-fitting lid and equipped with a steam inlet. After steaming, the seal is completed by giving the lids the second and final clinch.

Anchovies

1. Only strictly fresh anchovies should be used, preferably those not more than 3 or 4 hours out of water. Dress the fish; that is, remove head and viscera and wash in fresh water or dilute salt solution (3%). The fish should be agitated gently during the washing process to remove any blood and loose scales. There is a loss of about 30% of the total weight of the fish in dressing.
2. Allow the fish to drain a few minutes. Then soak them in a 60° salinometer brine for 11 to 15 minutes. After this time, the fish have absorbed a sufficient amount of salt. Place the fish on screens and wash under a fine water spray. Allow to drain for 15 minutes.
3. Arrange the fish, without overlapping, on the oiled wire mesh trays and place the trays in the smokehouse preheated to 110°F. Dry at this temperature for one hour.
4. After this drying period, smoke for two hours; during this time, raise the temperature of the smokehouse to 150°F. This represents a rise in temperature of 5°F for each 15 minutes of smoking.
5. Cool the fish to room temperature. Pack in ½ pound tuna cans or ¼ flat cans. The latter, if available, are preferable. For the ½ tuna flats, add one ounce of vegetable oil (cottonseed, corn, or soya) to the can before packing. Pack the fish in rows, alternating the heads and tails, with their back sides down. Place the second layer of fish on their sides and continue the third layer in the same manner as the first. Add an additional ½ ounce of vegetable oil. Vacuum seal or steam exhaust for 12 to 15 minutes, then seal.
6. Process for 75 minutes at 100 pounds pressure (240°F) and then water cool immediately.

Hot Smoked Salmon

1. Fresh or fresh-frozen salmon may be used. The frozen fish should first be thawed by immersing in cold running water for 8 to 10 hours. Dress the whole fish and wash thoroughly in fresh water or weak brine. Cut the fish into pieces of sufficient thickness to exact fit into the particular can size used. Remove the backbone section from each piece. Do not remove the skin at this time.
2. Wash the sections under a fresh water spray and drain slightly. Soak the fish in a 95° salinometer brine for 2 hours. Drain and wash in a fresh water spray. Drain again for 15 minutes.
3. Place fish skin side down on the screen trays and place the trays in the smokehouse at room temperature. Dry at room temperature for ½ hour.
4. After this drying process, smoke for 3 hours; during this time, raise the temperature of the smokehouse to 170°F. This time and temperature is sufficient to produce a suitable pellicle. Continue the smoking process for 2½

hours. This additional curing is necessary to produce a fine flavour and to cook the fish sufficiently to allow removal of the skin.

5. Cool the fish. Remove the skins and pack the meats solidly in the cans. One-half pound salmon cans are preferred. Add one ounce of vegetable oil. Vacuum seal or steam exhaust and seal. Process for 75 minutes at 240°F (10 pounds pressure).

Smelt

1. Dress the fish by removing the heads and viscera and wash thoroughly. Smaller smelt are more suitable for canning.
2. Soak the dressed fish for 45 minutes in a 60° salinometer brine solution. Use brine in the proportion of two parts brine to one part fish.
3. After brining, rinse the fish thoroughly in fresh water and allow to drain thoroughly. Arrange the fish evenly without stacking on the oiled wire screens.
4. Place the racks in the smokehouse preheated to 110°F. Dry the fish at this temperature for one hour. At the end of this time, close the air intake damper, adjust the exhaust damper, and begin the smoking process. Raise the temperature of the smokehouse to 130° - 149°F and continue smoking at this temperature for 3 hours.
5. Cool the fish and pack in cans. The smelt are packed in the same manner as described for anchovies. For the ½ pound tuna flat, add 1½ ounces of vegetable oil.
6. Vacuum seal or steam exhaust and seal. Process for 75 minutes at 240°F (10 pounds pressure). Water cool immediately.

Oysters

1. Only fresh live oysters should be used. Wash the shells thoroughly to remove any adhering sand or dirt. Steam the oysters in a steam box for 15 minutes at atmospheric pressure or in a retort for 5 minutes at one pound pressure. This procedure is preferable to shucking the oysters fresh, since in the steaming process the oysters become firm and develop a texture more suitable for smoking and for absorbing the smoke flavour. Remove the meats from the shells and wash thoroughly.
2. Soak the oyster meats for 5 minutes in a 60° salinometer brine. Large oysters, less than 200 per gallon, should be cut in halves or thirds before brining. Rinse and allow to drain thoroughly for 15 minutes.
3. Arrange the oyster meats on the oiled screens. Place the racks in the smoking chamber preheated to 100°F. Smoke for one hour, with both the intake and exhaust dampers fully open. At the end of this period, close both dampers and continue smoking for an additional ½ hour. Raise the temperature for a final ½ hour period. The last smoking operation tends to produce the desirable colour in the oysters.
4. Exhaust the smoke from the smokehouse and cool the oysters to room temperature.
5. Pack the meats tightly in cans, preferably ¼ pound flats. The cans must be well filled prior to closing and sealing. Add one ounce of vegetable oil. Vacuum seal or steam exhaust and seal.
6. Process for 60 minutes at 240°F (10 pounds pressure). Water cool the cans immeditely after processing.

Cured in this manner, oysters develop a very delicate smoke flavour, which does not obscure but supplements their normal piquant taste.

Razor Clams

1. The clams are opened by exposing them for several minutes to steam in a steam box at atmospheric pressure. Shake out the meats and clean the clams by removing the stomach and splitting open the neck. Wash thoroughly in fresh water. Cut each clam in three sections: neck, foot, and mantle.
2. Soak the clam meats in a 60° salinometer brine for 5 minutes. Rinse thoroughly and drain for 15 minutes. Arrange the meats on oiled wire screens.
3. Place the racks in the smokehouse preheated to 105°F. Smoke for ½ hour with all dampers open full. After this time, close the air intake, adjust the exhaust damper, and continue smoking for 2½ hours, but allow the temperature to rise to 140°F during the last ½ hour. Weight loss of the clam meats during this smoking process is approximately 25 to 30%.
4. Exhaust the smoke and cool the clams to room temperature.
5. The product may be consumed immediately or may be packed in cellophane bags and refrigerated for later use. For canning, pack the meats in ½ pound tuna flats. Add 1½ ounces of vegetable oil. Process at 240°F (10 pounds pressure) for 75 minutes.

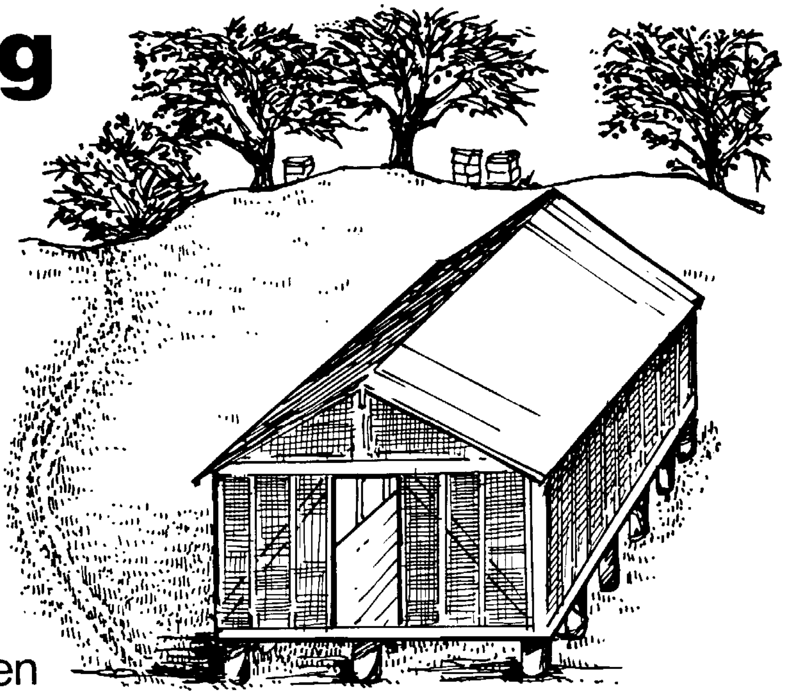
Rock Clams

Rock clams are handled in about the same manner as the razor clams, except that the smoking procedure is varied slightly. The prepared meats are placed in the smoking chamber preheated to 105°F. Smoke at this temperature for ½ hour, with all dampers fully open. At the end of this period, close the intake damper, adjust the exhaust damper, and continue smoking at 105°F for 1½ to 2 hours, allowing the temperature to rise to 120°F during the last ½ hour. Complete the packing and canning procedure in the same manner as that for razor clams.

Table 1. SALT TABLE

Salinometer Degrees	Ounces of Salt per Gallon of Water	Salinometer Degrees	Ounces of Salt per Gallon of Water
3.8	1.3	52.8	20.8
7.6	2.6	56.6	22.6
11.3	4.0	60.4	24.4
15.1	5.3	64.2	26.2
18.9	6.7	68.0	28.1
22.6	8.1	71.7	30.0
26.4	9.6	75.5	32.0
30.2	11.1	79.2	34.0
34.0	12.7	83.0	36.1
37.7	14.2	86.8	38.2
40.5	15.8	90.6	40.4
45.3	17.5	94.3	42.7
49.1	19.1	100.0	46.1

Constructing a Large Fruit Dryer & How to Use It



by Lee & Robert McPhadyen

The Dryer Construction

We were called on to construct and operate a fruit drying unit as a pilot project on very short notice. We did not have an opportunity to accumulate a supply of recycled material and (regretfully) had to buy fairly expensive new lumber.

The materials used in the construction of our structure cost approximately one thousand dollars but this we are convinced could be reduced by 1/2 to 2/3 by someone with the time and access to good used wood.

The structure we decided on had base dimensions of 12' x 24'. We felt a dryer this size would allow the processing of enough fruit to provide a reasonable supplement to the income of a small family farm or survival collective. The size or dimensions of the structure are not as important as consideration of its function.

First, we chose a location where prevailing wind or breezes (which carry off the moisture) would blow along the longest dimension of the building (Fig. 1).

The second consideration was to locate the building where it would benefit from the longest period of sunshine not only during each day but during the drying season.

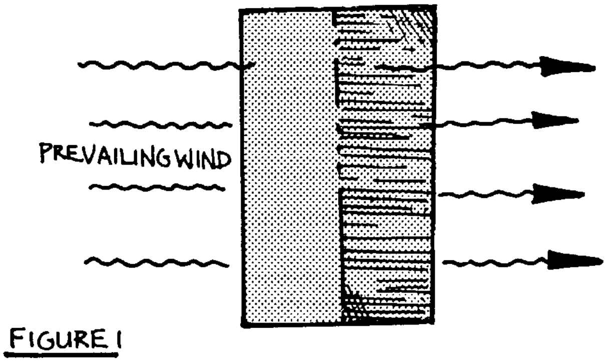


FIGURE 1

Thirdly, we chose a slight elevation, and then used foundation posts or cribbing to elevate the structure even more. This meant a free flow of air around the entire structure. A frame 12' x 24' was constructed of 2" x 6" planks and floor joists (2" x 6") were fitted into the frame on 2' centres. These were cross-braced with scrap materials for strength (Fig. 2). We managed to locate a load of cheap 2" x 6" planks and decided to use these for the floor decking instead of more expensive ¾" plywood. Anything sturdy could be used. By this time, we were ready to raise the walls. Our floor was good and level so we fabricated the walls flat on the deck using 2" x 4" lumber. The studs were cut to 7' lengths; this could be shortened by a few inches but should not be shorter than 6½'. There is no advantage of studs longer than 7'. The studs were placed on 24" centres which would allow simple application of standard fly screen of 24" or 28" widths later on. A provision was made in one end wall for a 36" door frame for unloading fruit from a truck plus one space between studs on a side wall for alternative access to the structure. As each wall was assembled it was raised into place and braced to secure it in position. When all four walls were raised 2" x 6" planks were cut into 12' lengths and placed in position on the upper **plate** off the walls. Two inch by four inch lumber spacers were spiked to the plate between each plank and the plank in turn was spiked (3" nails) to the

FIGURE 2

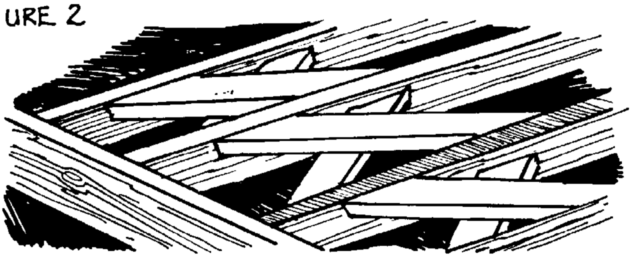


FIGURE 3

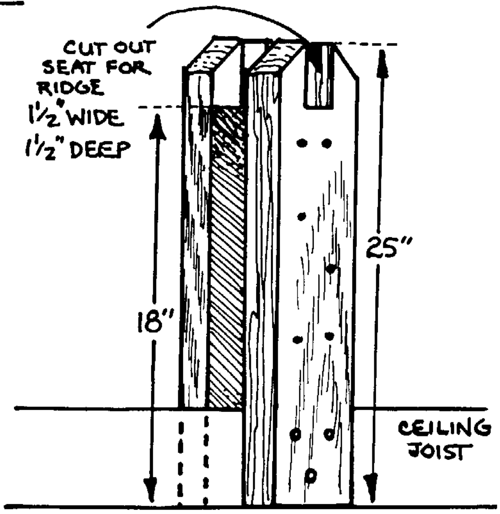
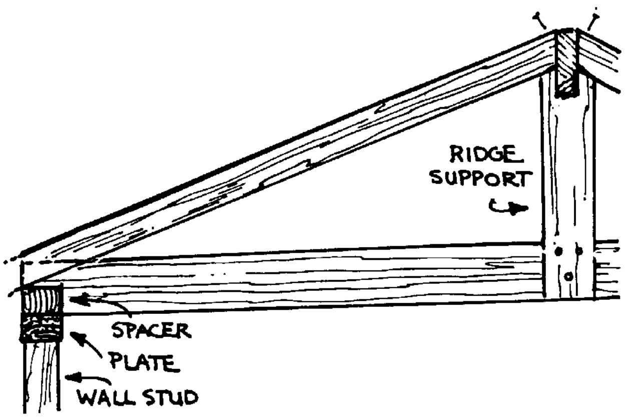


FIGURE 4



ends of the spacers to provide 2' centres for the 2" x 6" planks (Fig. 4). Walls are plumbed and squared as the planks are spiked to the spacers. We planned the roof to provide extended eaves to prevent direct sunlight from hitting the drying fruit at any time. On the other hand the eaves should not extend to a point that might inhibit the flow of air through the structure. The roof was constructed by mounting a ridge board of 2" x 6" plank mounted on supports fastened to the ceiling joists as in Fig. 3.

To make the support, cut two pieces 2" x 6" plank 25" long and one piece 18" long. Nail them together with a shorter piece sandwiched in between the longer two. This creates a slot at one end 5½" deep allowing you to set the support over the ceiling joist to form centre of roof. Cut a slot on the opposite end 1½" wide x 1½" deep to carry the roof ridge. For a strong roof, one support should be made for each ceiling joist. Our roof withstood a 70 m.p.h. windstorm last December. Next we took 12' long 2" x 4"s and cut the ends to fit to the roof ridge, using the first one as a pattern to mark the rest. Nail the top end of each 2" x 4" to the roof ridge, and the bottom ends to the 2" x 6". The bottom ends will be resting on the spacers. This will provide an adequate overhang for shade.

We then applied an overall roof of 5/16" unsanded sheathing plywood followed by the cheapest 50 lb. rolled roofing (using plenty of lap cement and allowing a fairly generous overlap for a little extra strength). If the budget hasn't been exhausted the walls can be closed in with fly

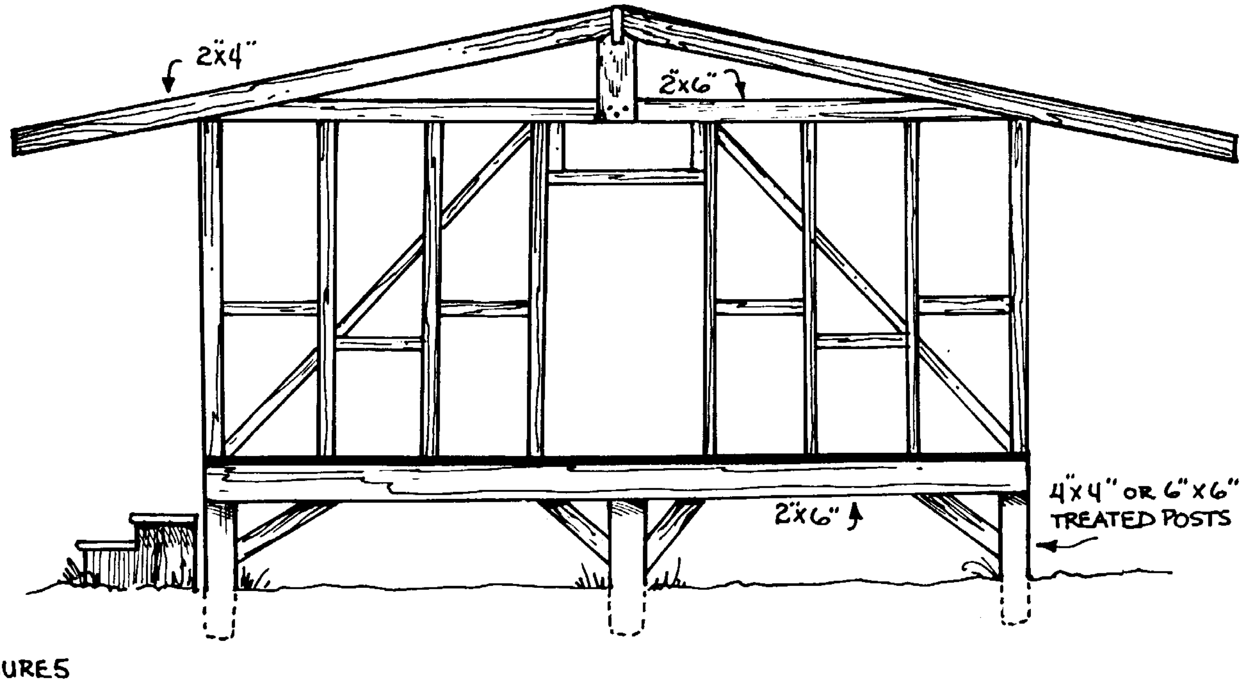


FIGURE 5

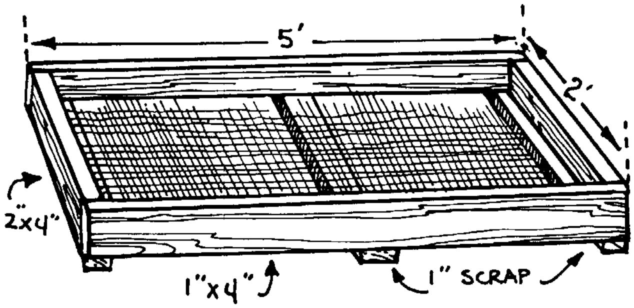


FIGURE 6

screen stapled to the studs and then further secured with plaster lath. Screen doors can be made for the two entrances. For drying racks, we made frames 2' x 5' using 1" x 4" strapping lumber on the sides and 2" x 4" scrap on the ends. Fly screen was stapled to the bottom with end runners and the centre support was made from 1" scrap (Fig. 6)

Spaces between studs should be cross-braced for extra rigidity and overall strength.

Drying Fruits

In the drying of fruits, we used only the natural elements, providing the previosuly described shed to protect the fruit from the direct rays of the sun, as these destroy the vitamin A content. The shed also provided a cover from rain. We had some rain while certain fruits were drying, and while the high humidity slowed the drying process, so

long as the fruit was not wetted by the rain, we could detect no ill effects from the wet weather. We used no sulphur and found that with the exception of very ripe pears, the colour remained very good for all fruits. We were drying large quantities and were not able to harvest the fruit as I have stated in the following recipies. However, each day we would pick over the trees, taking only the ripest fruit. With cherries and prunes, we were able to wait until the fruit was withering from the stems. If you are buying your fruit, it is impossible to get this ripe, but the fruit can still be satisfactorily dried; it just won't

If fruit is too green when picked, and stored to colour, as is the case with most commercial fruit sales, then you sadly miss out on flavour and can end up with a bitter taste. When picked too green, the fruit does not really ripen; it simply changes colour. The sugar content does not increase from the time it is picked; just what little sugar that was there concentrates.

If you are buying a large quantity from a fruit grower, then demand that the fruit be left on the trees for a longer period than is customary. Most growers are scared by this, as risk of damage because of wind, hail, birds or too much rain increases, but I have managed to convince growers that I must have ripe fruit.

Packing & Storing Dried Products

Once dry, pack your fruit immediately in containers such

as tins, jars, plastic bags, etc., that will not allow the reabsorption of moisture and contamination by eggs of insects etc.

Dried fruits are not readily susceptible to spoilage by moisture absorption, but will deteriorate more quickly if not stored properly. Once packed, store in a dark cool place.

Preparation of Dried Fruits

Restoration: Soak the product in cold water for 1-3 hrs.; no longer. Use only enough water to restore to original size.

Grapes – Method 1: If you can buy or produce a type of grape that will stay on the stems, pick the bunches and hang them to dry under eaves on a string.

Method 2: Submerse ripe fruit in boiling water for 2 minutes to check *the skin. Place it on racks and dry.

Method 3: Remove the grapes from their stems, place them on racks and dry. This method takes longer than method 2.

Sun Cooked Preserves: Wash and hull strawberries, raspberries or other berry fruits. Place them in shallow enamelled pans. Drizzle honey over the fruit and mix well. Cover the pans with sheets of glass and place in the sun. Let stand for several days until fruit is a jelly-like consistency, stirring several times each day. Pack in hot clean jars and sterilize in hot water bath 2-3 minutes. Enjoy them on cold snowy days. Open a jar of summer and eat.

Apricots: For small quantities, if you are fortunate enough to have your own trees, let the grass grow as apricots ripen and dry the fruit as it falls to the ground. The grass is a perfect cushion and very little fruit is damaged. This degree of ripeness creates the perfect dried apricot. Collect the fruit as it falls, split, place on racks open side up and allow moisture to escape. If the weather is very hot, they should be ready in 2-5 days. When adequately dry they will separate from each other when several are balled together in your hand. If they overdry, no harm is done, they keep very well but may need some moisture before being eaten. Better to overdry than leave too much moisture in them as they mould if too wet.

Honey Apricots: Prepare solution of 1 part honey to 2 parts water. Bring to 200° F. Split the apricots, place them in a wire basket, submerge in honey mixture and count to 20. Take out and place apricots on racks and let dry. A more extravagant method is to drizzle some pure honey over the apricots once they are on the racks. It's time consuming but gives some very special eating for winter. Fruit done this way will be a little more tacky when dry. There is no need to turn aprictos while drying.

Cherries: Best picked when the fruit is beginning to shrivel from the stem.

Method 1: Dip whole cherries into boiling water for 2 minutes. The same water can be used several times. It may have honey added to it if desired. Place on racks and dry.

Method 2: Pit the cherries. It's time consuming and tedious, but it's nice to have no pits in some fruit. I have not found this method allows the fruit to dry any quicker. Place pitted cherries on racks, let dry. There is no need to turn.

Method 3: Wash whole fresh fruit, put on racks and let dry 3 to 5 days and longer if needed (up to 4 weeks).

Pears – Method 1: Pick ripe but firm fruit. Wash, stem and cut unpeeled and uncored into very thin slices. You can purchase machines that do this chore quickly and evenly. Place slices on racks but do not turn. They will be dry in 24 to 36 hours.

Method 2: For a darker but very sweet treat, allow your fruit to ripen till ready to fall or let it fall on thick grass. Wash, stem, cut in quarters, remove core if desired, and place the skin on racks. This method takes longer to dry and fruit oxidizes more but makes delicious eating. If you wish, fruit may be peeled but if very ripe, is likely to stick to the screens.

Peaches: Harvest peaches as late in the ripening process as allows them to be handled without becoming badly bruised. I did not peel mine. However, if you have a slip skin type available to you, do so. The skin once dry, is reduced, and is hardly noticeable. Halve the peaches, pit, and place in racks. They may take up to 7 days to dry.

Nectarines: Do the same as for peaches.

Plums & Prunes: Harvest when the fruit begins to wither from the stems.

Method 1: Dip the whole fruit into boiling water for 2 minutes, to check the rather tough skins. Do not immerse too many at once as the water must boil around the fruit to achieve desired checking. Place on racks and dry. They may take up to 3 weeks to dry as these fruit are late in the season. I found this method not as satisfactory as the 2nd method. The fruit skins did not check evenly and some fruit simply did not dry as moisture could not escape.

Method 2: Split the fruit, remove pip or stone, lay open side up on racks, do not turn, and let dry. They can take up to 2 or 3 weeks to dry.

We were able to do all of our drying with the sun's heat and the breeze evaporating. Some geographic areas may have to supplement this with artificial heating etc. – but this would be a whole other subject.

In this past season all fruit took much longer to dry, but with equally good results. However, with the longer time on racks, the racks need rotating and checking, as some pieces of fruit are more likely to mould. Discard any of these. Allow a lot of space, 18" between racks and as much space as possible between stacks of racks, to allow a really good air flow. This is particularly important during periods of cool, cloudy, or rainy weather. Fruit is also more likely to collect dust during extra time on the racks. If desired, this can satisfactorily be removed before storing your fruit. Fill a large pot with water, allowing a 2" headspace. Bring the water to a boil. Place your fruit in a wire basket that will fit in the pot and not allow the fruit to escape through the holes in it. Submerse the fruit in boiling water for 10-15 seconds, shaking it up and down as you do so. Remove the basket from the water and tip the fruit, one layer deep, onto racks to dry off. A warm sunny day with a breeze is the ideal day for this procedure. Within 2 hours the fruit is quite dry, soft, clean and ready for immediate storage before further dust can settle on the fruit. This process does not cook the fruit in any way. The plunge is too short in time. In 2½ hours, you can process at least one hundred pounds of dry fruit.

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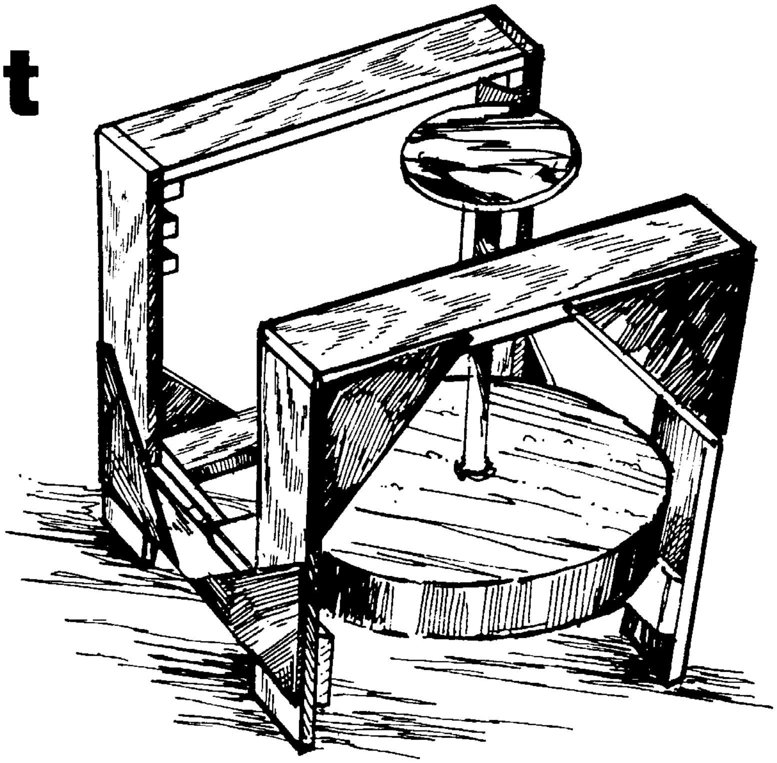
*check means to cage or make small breaks in the skin, by shrivelling it a little. This allows moisture to escape more readily.

A Home Built Kick Wheel

by Barry Barnes



The first step in building this wheel is to cut 2" x 6" stock into these sizes: 2 - 36" seat supports, 2 - 28½" front leg supports, 1 - 36" bottom support for back, 1 - 33" bearing base support, 1-36" top support for front, 1-9" top bearing support, 2 - 30" bottom support for sides (inside), 2 - 19" bottom support for sides (outside). 1-36" seat. Next, cut a 60 inch - 2" x 4' stock into 2 - 30" pieces for the foot supports. Now rip a piece of 2" x 4" x 18" in half long-ways, then cut these two 18" pieces 3 times into 6" pieces. These will be your seat support pieces.

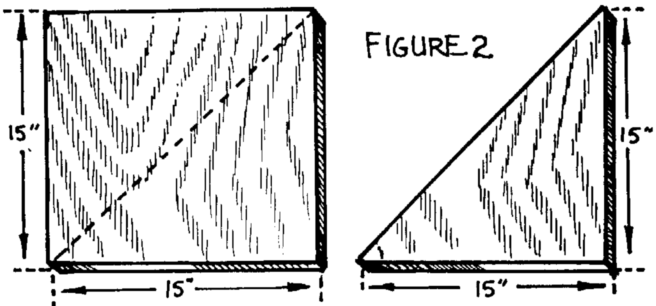


FIGURE 2

PLYWOOD BRACES

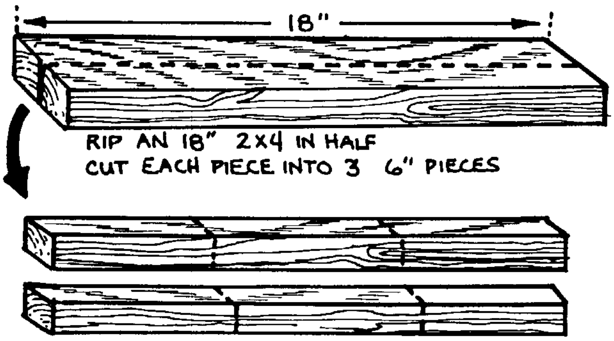


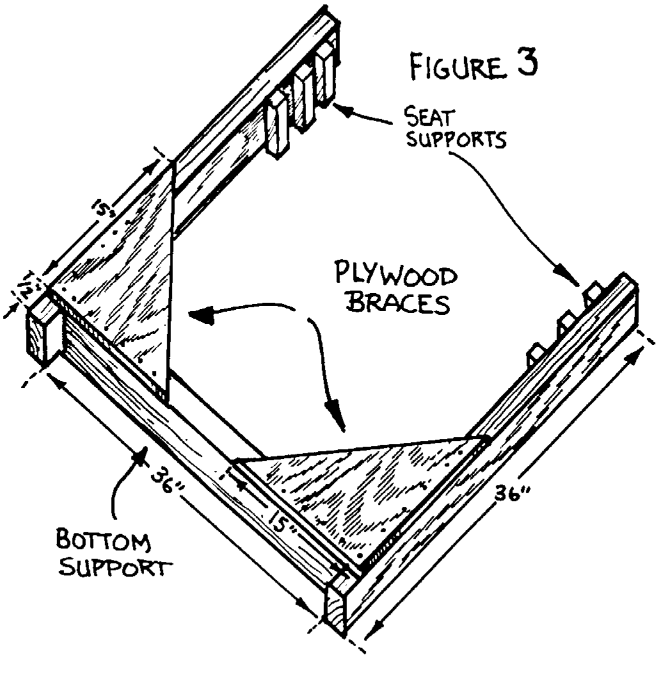
FIGURE 1

Cut 4 squares of either ½" or ¾" exterior plywood into 15" squares. Cut these pieces from corner to corner so you have 8 pieces that are shaped as illustrated in figure 2.

Place the two 36" seat supports on the floor. Glue and nail or pre-drill and screw the 36" bottom support ½" from the bottom of the posts. Then glue and nail (or screw) two of the plywood braces on as shown in figure 3, being sure to square up all the parts.

Stand the 2 - 28½" front leg supports on the floor and glue and nail (or screw) the 39" top support on the top.

FIGURE 3



Then add two braces and bring to square.

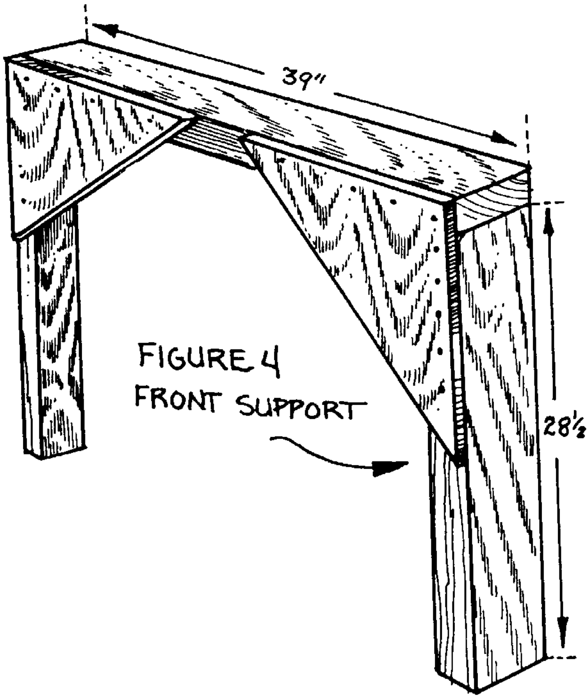


FIGURE 4
FRONT SUPPORT

Place the 2 - 30" bottom side supports on the floor and measuring 5½" from each end secure* the 2 - 19" bottom supports to each one.

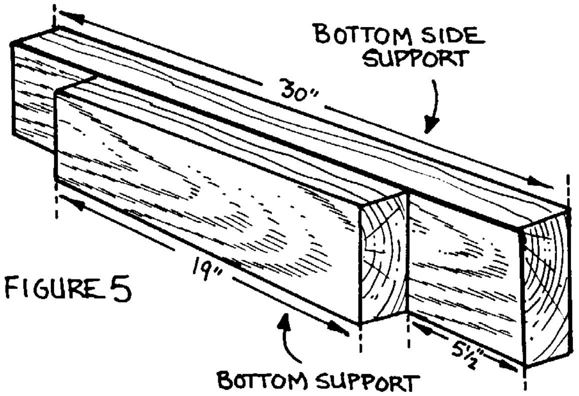


FIGURE 5

Stand the front and back supports on their sides and secure* the bottom side supports with the 30" length on the inside. Nail these temporarily and then attach the plywood supports (bringing to square). When you are satisfied that the pieces are all true drill through the plywood supports and the 2" x 6" supports and attach permanently using at least ½" x 5" bolts with large washers on both sides (Fig. 6).

Your bottom bearing should be bolted to the bearing base support after centering. Mount the bearing base support with the centre of the bearing 7¾" from the front of the front supports.

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* Glue and nail or screw.

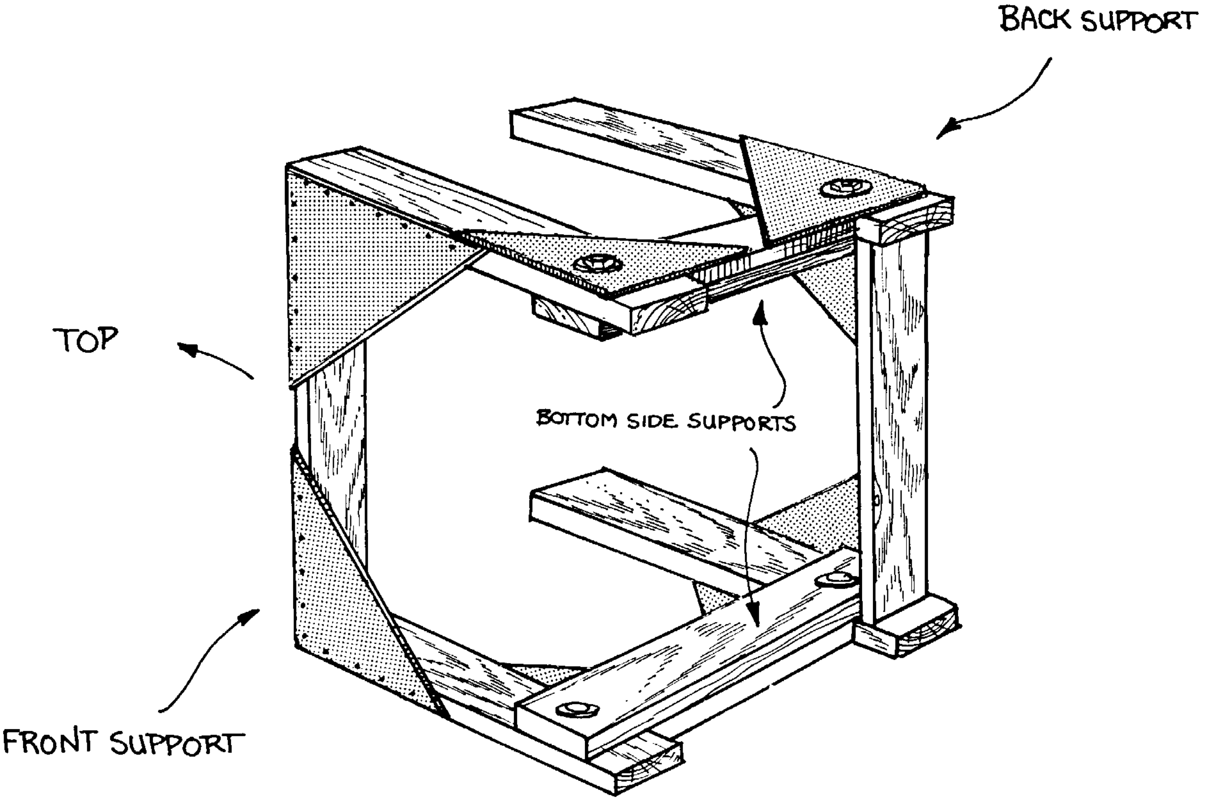
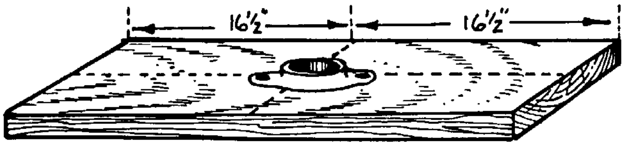


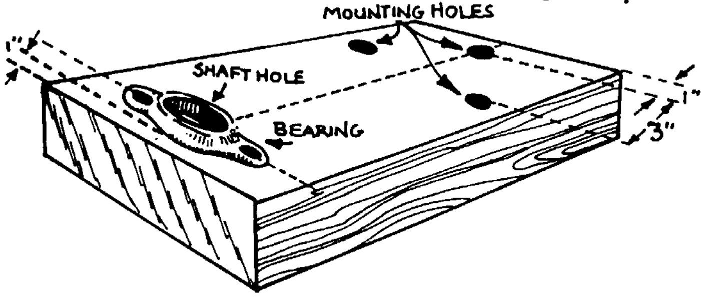
FIGURE 6

FIGURE 7



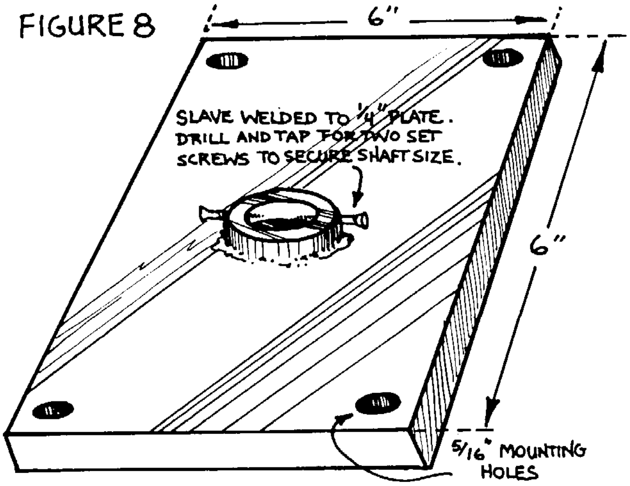
Taking the piece of 2" x 6" x 9" stock cut earlier, drill 3 mounting holes as noted, the top bearing holes and the shaft hole. This mount is turned over and mounted bearing side down (to keep clay out) in the centre of the front top support. Note that the top bearing and the bottom should be directly over each other. Use a level to do this. After you place the shaft with flywheel attached in the bottom bearing, you should have enough adjustability to align and then bore your mounting holes through the front top support.

FIGURE 9



One method of constructing the flywheel is to pour using concrete. If you can find an old belt wheel about 30" in diameter you should have the bearing hole **shimmed** or **sleeved** and some method devised to hold the wheel to the shaft, e.g., set screws. You could then fill the open spaces with chicken wire and concrete. Another method you could use if you do not have any luck in finding the old belt wheel is to take two plywood discs, some flanges and concrete and again pour the wheel. I will outline this second method but the basic principal is the same and could be adapted to the belt wheel.

FIGURE 8


6"
SLAVE WELDED TO ¼" PLATE. DRILL AND TAP FOR TWO SET SCREWS TO SECURE SHAFT SIZE.
6"
5/16" MOUNTING HOLES

A POSSIBLE FLANGE DESIGN

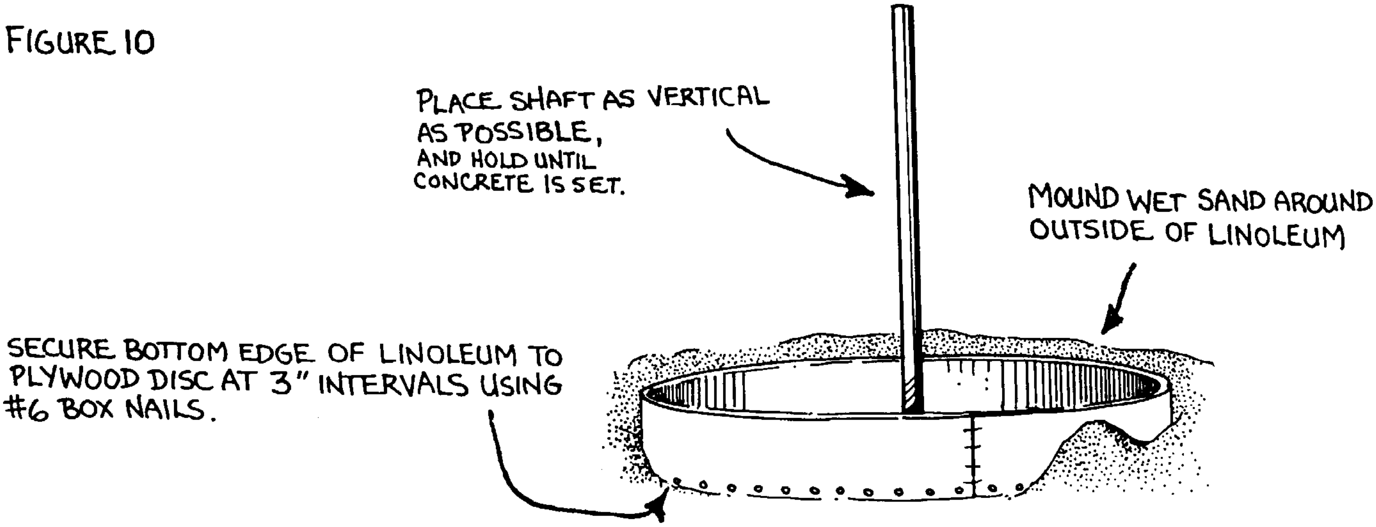
Cut two 30" diameter discs using ½" or ¾" exterior plywood. Drill 6 evenly spaced ¼" holes through both discs at least 3" from the edge. Attach a flange to both discs.

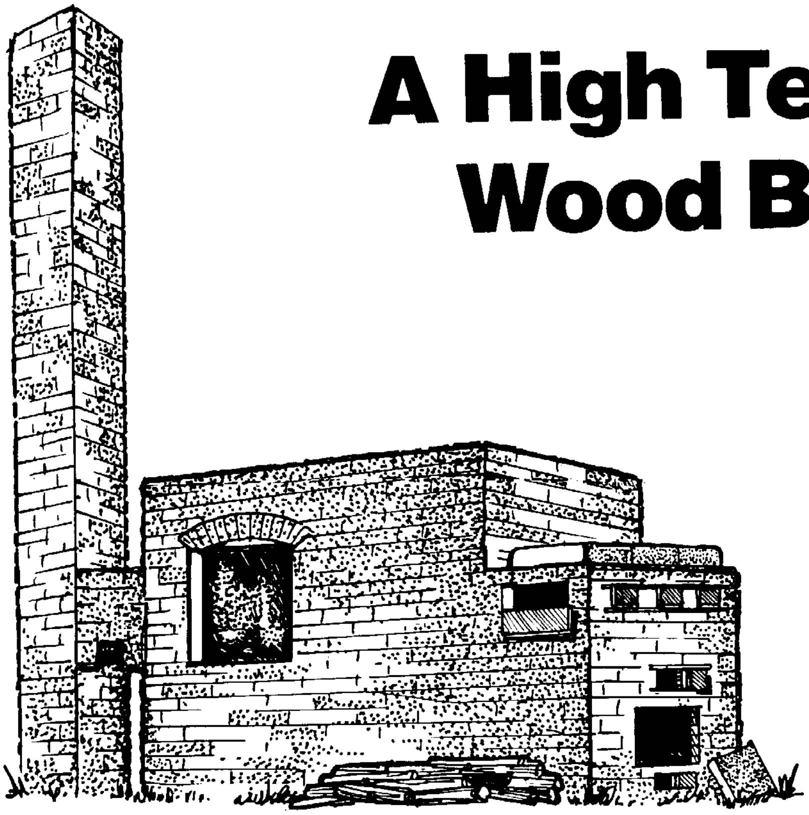
Take one plywood disc and turn it with the mounted flange side down and set it on a bed of wet sand. Wrap the outside of this disc with a piece of linoleum 4½" high and secure the bottom edge at 3" intervals using no. 6 box nails. Place 6 - ¼" x 6" bolts through the holes you drilled in the bottom disc and insert your shaft through the hole and into flange. Using a 5-1 mix, pour your form full of concrete and level. Now place the top disc down over your bolts and shaft, and let harden at least 1 week.

Drop your top bearing and support over the top of the shaft and tighten. Your bearings should be of the self-aligning type so no need to worry that the shaft will be straight. The last step is to mount your wheel head on your shaft. You can construct a wheel head out of ¼" plate steel or even wood, but best to purchase an aluminum one from the many sources listed in such magazines as "Ceramics Monthly."

Using a spacer of at least 2", mount the two foot supports above the wheel by attaching them to the front and back supports with nails and or screws. You may want a splash pan but I'll leave that up to you – happy bolting.

FIGURE 10


PLACE SHAFT AS VERTICAL AS POSSIBLE, AND HOLD UNTIL CONCRETE IS SET.
MOUND WET SAND AROUND OUTSIDE OF LINOLEUM
SECURE BOTTOM EDGE OF LINOLEUM TO PLYWOOD DISC AT 3" INTERVALS USING #6 BOX NAILS.



A High Temperature Wood Burning Kiln

by Ivan McMeekin

The wood-burning kiln was built at Bagot, Australia, for a number of reasons, and though most of them relate to that particular situation, I feel that this kiln, which may be fired to 1300°C with ease, may be of interest to artist-potters and students elsewhere.

Having decided to build a wood-burning kiln, the next decision was the question of size. The kiln was to be a training kiln, not a production kiln, and had to be small enough to necessitate frequent firings to give trainees adequate opportunities to get to know the setting, firing, cooling, and drawing routine and to develop the judgment and skills required. Firing is at least as important a part of pottery as throwing, and I feel that trainees or students must be taught to fire while they are being taught to throw. So the kiln had to be small enough for frequent firings and small enough for the firing not to be an upheaval, slowing down, or dislocation of the workshop routine. On the other hand, it had to be big enough for full-sized pots to be made and for trainees to feel that the number of finished pots drawn from a firing was adequate reward for their labours. A setting space of ten cubic feet seemed to meet these requirements, and from this I proceeded to the actual design of the kiln.

Though wood-firing was to be a feature of the design, the kiln was not to be an anachronism and was designed in the light of as much contemporary fuel technology as I have been able to acquire. The best and most up-to-date materials and a good pyrometer was used.

The design will be described in terms of the following concepts:

The Chamber or Setting Space: The main or central part of the kiln in which the pots are set for firing.

The Furnace or Fire Box: The part of the kiln in which the heat is generated. This is a traditional concept, and mainly applicable to kilns burning solid fuels like wood, coal, or coke. Many contemporary kilns do not have a separate space for the generation of heat; most electric kilns, LP gas kilns, and some oil-burning kilns generate the heat in the actual **chamber or setting** space.

The Chimney: This needs no definition, but it may be worth mentioning the three main functions of a chimney: it generates draught so that (a) sufficient air may be drawn in through the fuel to burn it; (b) the stream of burning gases may be drawn into the setting to transfer the heat to the pots; and (c) to carry away the burnt-out waste gases.

The Throat: This is the part of the kiln which is used to feed the heat and burning gases generated in the **furnace** through into the **chamber**, and usually consists of a space within the central area of the kiln, separated from the **chamber or setting space** by a low wall called a **bag-wall** or **baffle**.

The Flue: This is the passage which connects the **chamber** to the **chimney** and conveys the waste gases to the chimney. It is also an important link transmitting the pressure generated in the **chimney** to the **furnace**, enabling air to be drawn into the fuel.

The Flameways: These are spaces between and around the bungs of saggars or the setting of bats and props, which enable the flame and gases to circulate in the chamber transmitting the heat to the setting. Setting the chamber too full, so that the flameways are too small for their job, is sometimes a cause of failure to achieve the required temperature. The pattern of the flameways is also important; they should be arranged so that they draw the heat into the cooler parts of the setting.

In addition, kilns need to have a **door** providing entry to the chamber, and a **damper** to control the strength of the draught generated in the chimney.

In the arrangement or disposition of these parts the kiln is a down-draught, or in this case more accurately a cross-draught kiln, in that the burning gases are fed into the bottom of the throat on one side, pass into the chamber over the top of the bag-wall and through bleeding holes at the side of the bag, and are then drawn downward and across the setting to the flues, which are at the bottom of the chamber on the opposite side of the throat. The gases then pass into the chimney, which is a separate structure. This disposition is nearer to Oriental cross-draught tradition than to European down-draught tradition. This applies particularly to the relative levels of the parts; the inlet from the firebox, for example, being below both the chamber floor and the outlet flue. This gives a better draught from cold and enables the chimney to be shorter. Some kiln designers maintain that to lower the outlet in relation to the inlet improved temperature distribution at the end of the firing, but in this kiln there is only 30° to 40°C difference between the hottest and coolest parts of the setting, which to my mind is satisfactory and could not perhaps be lessened by changing the relative levels in any case.

The relative size of the various parts of the kiln is based firstly on the study of proportions of other kilns, both down-draught and cross-draught, and secondly on experience gained in designing, building, and firing the round down-draught kiln at Sturt and the oil-drip kiln at the University of New South Wales. In describing these sizes, the cross-section area of the chamber floor is taken as 100, and the other sizes described as percentages of this area, i.e.:

Area of chamber floor	702 sq. ins.	100
Area of grate	281 sq. ins.	40%
Area of throat	129 sq. ins.	18½%
Area of exit flues	50 sq. ins.	7%
Area of main flue	85 sq. ins.	12%
Capacity of setting space	36" x 24" x 20"	10 cu. ft.

These are proportions that have been found to work well in this context, but it is essential to remember in kiln design that each particular design must be worked out in relation to its unique features. For example, the relative sizes of kiln parts change with scale; a chimney cross section area of 1% in a 30 ft. diameter coal-burning down-draught kiln may work excellently, but in a tiny 3 cu. ft. test kiln would be ridiculously small. However it is possible to generalise to some extent: (a) A wood burning fire-box (40% in this kiln) is better too big rather than too small; it can always be partially blocked in if it proves too powerful a heat source and too expensive in fuel (and this incidentailly is a good general principal – design all openings so that they will prove too big rather than too small. It is much easier to partially block them in than to pull down the whole structure so that they may be enlarged). (b) The throat should be adequate and larger than the outlet flue. In this kiln, it is more than double the outlet, and contains a vertical pillar, which is there to spread the flame toward the sides of the setting space. Once generated, the heat is not much use in the firebox; it must be passed into the chamber as easily as possible, subjected to maximum turbulence there, and as far as possible bottled up by an outlet which is as small as draught consideration will allow, so that as much heat as possible is transmitted to the setting. (c) The chimney should again be too big rather than too small and fitted with a damper, so that in the event of the draught being too strong, it may be decreased by pushing the damper in. Like the other areas, the size of the chimney is influenced by the size of a brick – 9" x 4½" x 3". In this case, a brick by a brick plus two joints was the nearest size suitable.

The firebox or furnace is a type that Michael Cardew first introduced me to at his Wenford Bridge pottery. It is basically a French design and has been described both in **A Treatise on the Ceramic Industries** by Emil Bourry and in **A Potter's Book** by Bernard Leach. I understand that the Sevres porcelain factory still fires with wood and still uses this type of firebox. I have modified it so that it acts more like a gas producer, adding a cover to the box and a side stoke-hole, providing three inlets for primary air, an inlet for an ember air supply, and fitting all inlets with sliding metal shutters. I have also increased the depth of the box in relation to its width, with the idea of making it easier to produce the carbon monoxide required for reduction by having a deep fuel bed.

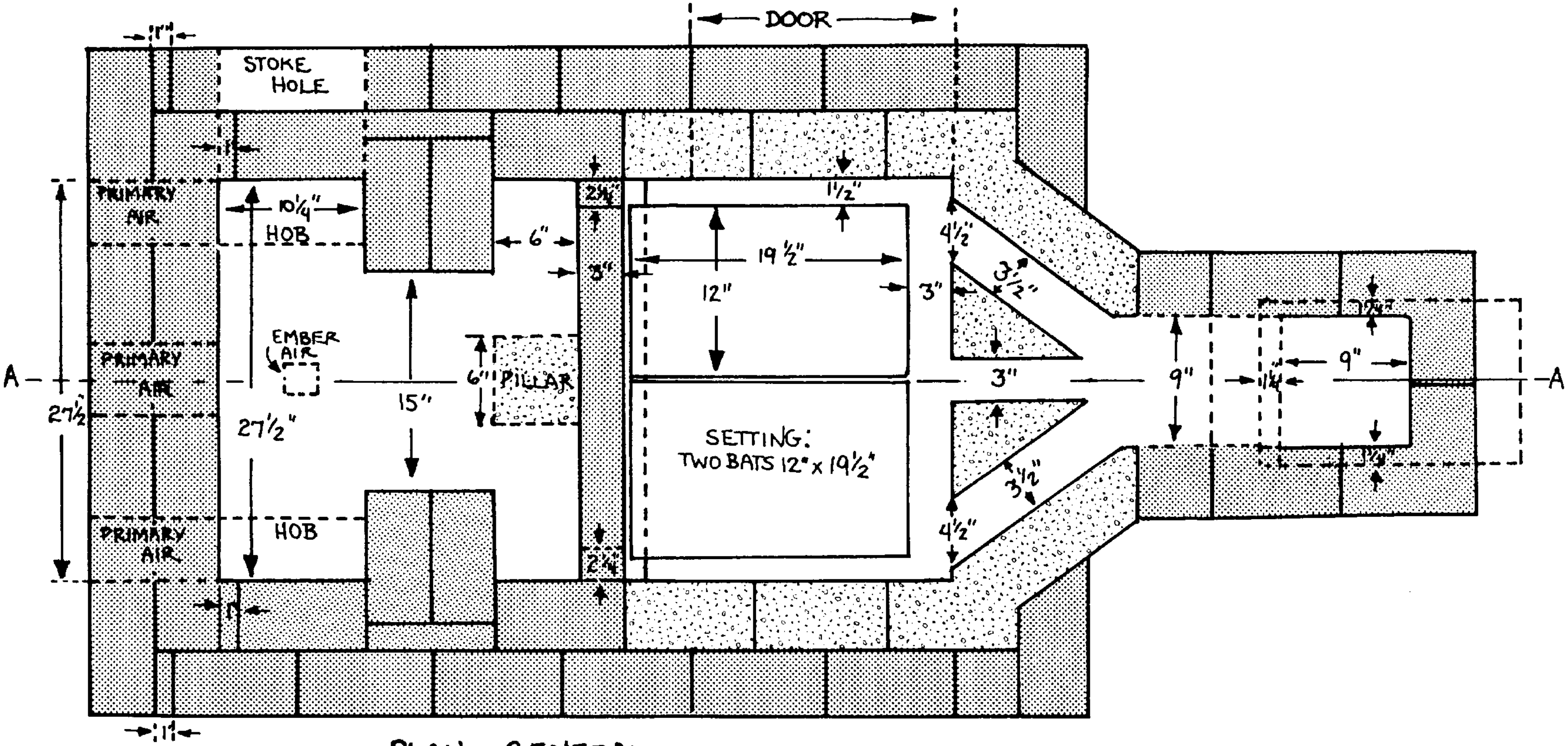
The height of the chimney was worked out in accordance with the formula suggested by Baker on p. 191 of **A Potter's Book**, i.e.:

3 ft. of chimney for every 1 ft. of downward pull.
1 ft. of chimney for every 3½ ft. of horizontal pull.

Effective chimney height is taken to be the difference in level between the mean inlet at the firebox end of the kiln and the chimney top. In this case, the mean inlet level was considered to be about halfway between the level of the primary air inlets and that of the secondary air. This is obviously something not amenable to exact calculation. In firing, the draught proved to be adequate in that the damper was never pulled right out.

The kiln was built on an already existing concrete floor. The structure consists of an inner lining of hot-face insulation brick: Morlite 28 is used in the upper part of the throat, where the highest temperatures are likely to be met; Morlite 25 is used for the arch, to line the remaining three walls, for the chamber floor, the flue, and to back the high-alumina brick in the lower bag-wall; Morlite 23 is used to insulate the ash-pit floor, and for the door and stoke-hole blocks.

High-alumina dense firebrick was used where conditions were likely to be most severe – i.e., for the fire-arch and the lower part of the bag-wall. It is important to leave dry joints at either end of the lower bag, to allow for expansion. These bricks will be the first to get hot and will expand before the main structure expands. The upper part of the bag-wall should be set dry. The remainder of the structure – the firebox, the outer shell of the kiln, and the chimney – are all of a medium-grade dense firebrick. The door is of Morlite 23 squares, stuck together to make up 9" x 9" x 9" blocks. The damper is cast in a suitable grade of refractory concrete,



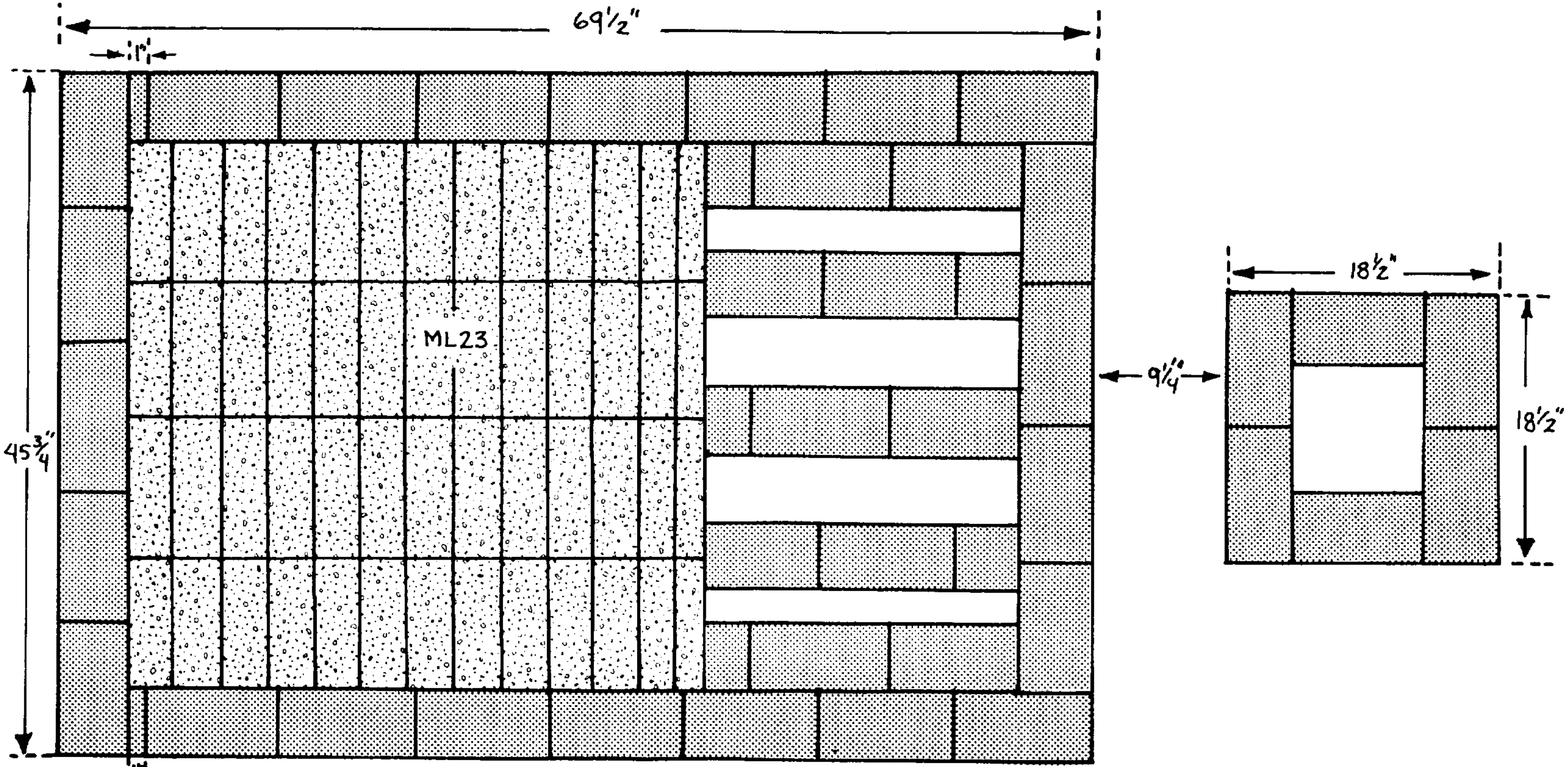
PLAN ~ GENERAL

HIGH TEMPERATURE WOOD-BURNING KILN

CAPACITY OF SETTING SPACE: 36" HT. x 24" x 20" = 10 CUBIC FEET
AREA OF CHAMBER FLOOR: 27.5" x 25.5" = 702 SQ. IN. = 100%
AREA OF GRATE: 27.5" x 10.25" = 281 SQ. IN. = 40%
AREA OF THROAT: (27.5" x 6") − 36 = 129 SQ. IN. = 18½%
AREA OF EXIT FLUES: TOTAL 60 SQ. IN. BLOCK TO 50 SQ. IN. = 7%
AREA OF MAIN FLUE: 9.25" x 9.25" = 85 SQ. IN. = 12%
AREA OF CHIMNEY: 9.25" x 9.25" = 85 SQ. IN. = 12%
HEIGHT OF CHIMNEY: 15 FT. FROM GROUND LEVEL

- ▨ HOT-FACE INSULATING REFRACTORY
- ▨ MEDIUM-GRADE DENSE REFRACTORY
- ▨ HIGH-ALUMINA REFRACTORY

NO CEMENT BRICKS TO BE USED



PLAN~BOTTOM COURSE

MATERIALS

HOT-FACE INSULATING FIREBRICK:
MORLITE 28 100 ONLY 9"x4½"x3" SQUARES.
MORLITE 25 320 ONLY 9"x4½"x3" SQUARES
MORLITE 23 100 ONLY 9"x4½"x3" SQUARES
ONE ONLY 200 LB. BAG SETTING MATERIAL
ONE ONLY 14 LB. CAN H. A. WASH-COAT

MEDIUM-GRADE DENSE FIREBRICK:
1300 ONLY 9"x4½"x3" SQUARES
55 ONLY 9"x4½"x1½" SPLITS
40 ONLY 9"x4½"x1" TILES
3 ONLY 15"x12"x3" FLUE TILES
1 ONLY 18"x9"x3" FLUE TILE
5 CWT ONLY SETTING MATERIAL

HIGH-ALUMINA DENSE FIREBRICK:
50 ONLY 9"x4½"x3" SQUARES
ONE ONLY BAG SETTING MATERIAL

WOOD FUEL: CUT TO 24"-26" IN LENGTH

or made of a high-alumina dense firebrick tile, and should be graduated so that it may be set accurately.

The kiln and chimney must be adequately strapped with buckstays at the corners and horizontal strapping consisting of 2" x ¼" angle iron and ½" diameter reinforcing rod, threaded and fitted so that the strapping may be screwed up to hand-tight when the finishing temperature is reached at the end of the first firing. No further adjustment should be necessary after this. The strapping should be set up before the main arch is built, so that there is no tendency to spring the freshly-laid walls as the arch is worked in.

The three primary air inlets, the secondary air inlet, and the ember air inlet are all fitted with sliding shutters, so that the amount of air admitted may be controlled accurately.

Fuel

Suitable fuel is essential with a wood burning kiln. It must be dry, and with this kiln, hardwood. The timber must be felled, cut to length, split, and then seasoned for at least a year or two before it will be dry enough to use. With green fuel, you simply cannot get the temperature, and with half-green fuel combustion is a little too intense, giving short flames and uneven temperature distribution. The size to split to must be learnt by experience. Toward the end of the firing, the pieces must be big or they will burn too quickly. The length of the firebox is 27½", and the wood **must** be cut 24" to 26" in length. If it is too short, it will fall through the ash pit; if too long, it will not go into the box.

If you are felling your own timber, trunk wood is preferable to branches, and the fuel must be reasonably straight and must be barked. City dwellers can use old telegraph poles, which are usually excellent fuel. Off cuts from timber mills may be suitable, provided they are not too light and small in section and do not contain bark. The bark accelerates the burning so that control over the kiln is lost.

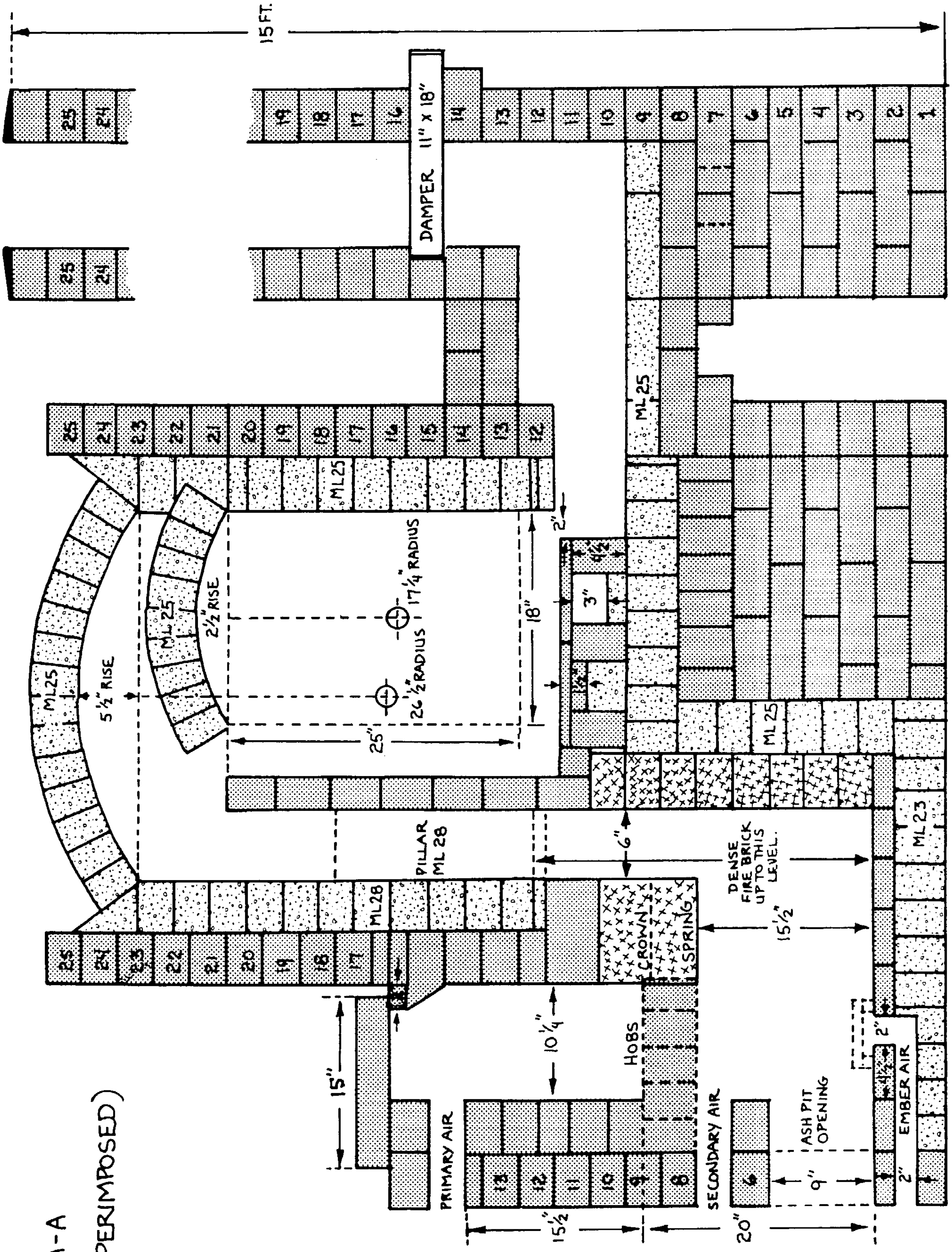
Firing the Kiln

At the start of the firing, a small fire is lit on the ash pit floor, the stoke-hole and all the metal shutters on the primary and secondary air inlets being closed. The opening at the base of the ash-pit slab is left open. The damper is adjusted to give sufficient draught to burn the fuel and draw off the steam from the setting. The size of the ash-pit fire is gradually increased as the temperature rises, and at about red heat (600°C) the burning fuel will be found to half fill the lower part of the firebox. At this stage, the upper part of the firebox is brought into use, a single deck of wood being laid on the hobs. This will ignite in a few seconds and the box will be starting to operate as it was designed to do – i.e., the fuel is now being stoked through the opening at the top of the box, and the primary air is being drawn in through the three inlets above the deck of fuel. Secondary air is now admitted through the inlet just beneath the deck of fuel, and the ash-pit slab is sealed into place, only a small amount of air being admitted at the bottom inlet to consume the ember. In the upper part of the box, now the main heat source, it should be noted that the fire burns up-side-down – the flame is drawn **down** through the burning logs and then through into the fire-arch and throat. As a log burns through, it falls into the ash-pit, and must be replaced by another, so that there is always a continuous layer or deck of fuel on the hobs.

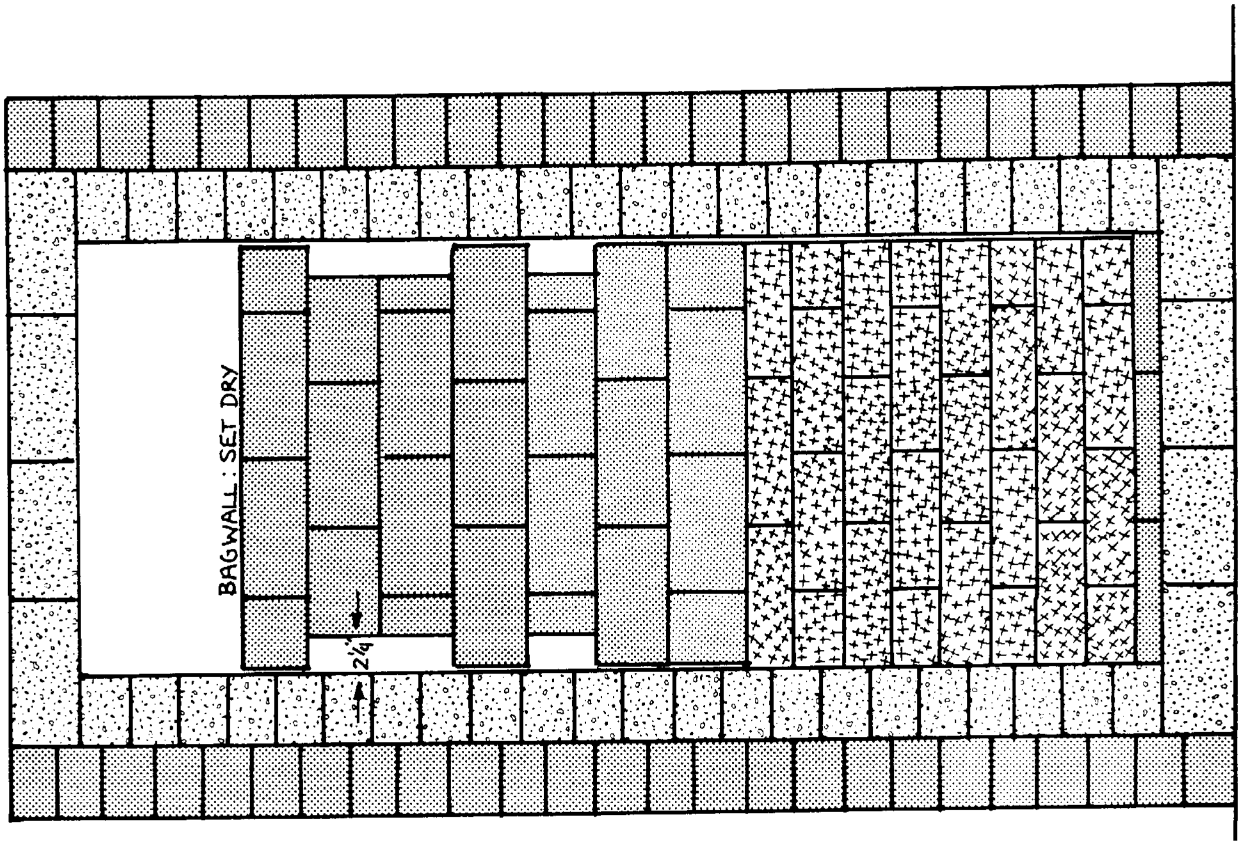
As the temperature rises toward 1000°C, the number of logs in the top of the box is gradually increased, so that by the time the temperature approaches 1000°C the box is kept at least half-full of fiercely burning logs. With this type of firing, the combustion is taking place in two stages. The primary combustion takes place in the upper part of the box, where the fuel is brought to ignition temperature, the volatile part is driven off in the form of unburnt gas, and part of the fixed carbon (charcoal) is burnt, before the remainder falls into the ash-pit to be burnt more slowly by the ember air supply. Between the deck of burning logs and heap of burning ember, the secondary air is drawn in, and by the time it reaches the throat it has become hot enough to initiate the second stage of the combustion: the burning of the volatile, gaseous part of the fuel. This should take place partly in the throat, but mainly in the chamber itself, where sufficient turbulence should be promoted for the volatile fuel and the hot secondary air to mix and burn as completely as possible. The advantages of this two-stage firing are considerable; the fuel is fully burnt, excessively high temperatures in the firebox and throat are avoided, and because the secondary combustion takes place in the setting itself, uneven temperature distribution is avoided.

If the ware is to be matured under reducing conditions, then at about 1000°C the shutter on the secondary air inlet should be partially closed, so that the total amount of air admitted is less than before. This increases the tendency for air to be drawn in through the primary inlets and through the fuel bed. Because the inlets are obstructed by the fuel itself, it will be necessary to increase the draught by withdrawing the damper off a little more: otherwise, the effect of the construction will simply be to slow down the whole process, so that neither reduction nor temperature rise is achieved. Because every 1% of carbon monoxide used in reduction represents a 7% loss in calorific value of the fuel burnt, it becomes necessary to increase the quantity of wood introduced into the box and the level of logs will probably now have to be up to the bottom of the primary air inlets. It should be possible to continue to the end of the firing with these settings, though it may be necessary to decrease draught a little over the last 30° to 40°C. At this stage, it does not matter whether conditions are oxidising or reducing as far as glaze colour is concerned. Provided that the kiln is properly handled, no raking of ember either in the top of the box or the ash-pit is necessary. At the end of the firing, the fuel should be allowed to burn down and the kiln allowed to cool rapidly to between 1200° to 1100°C. It should then be clammed up and allowed to cool slowly to room temperature.

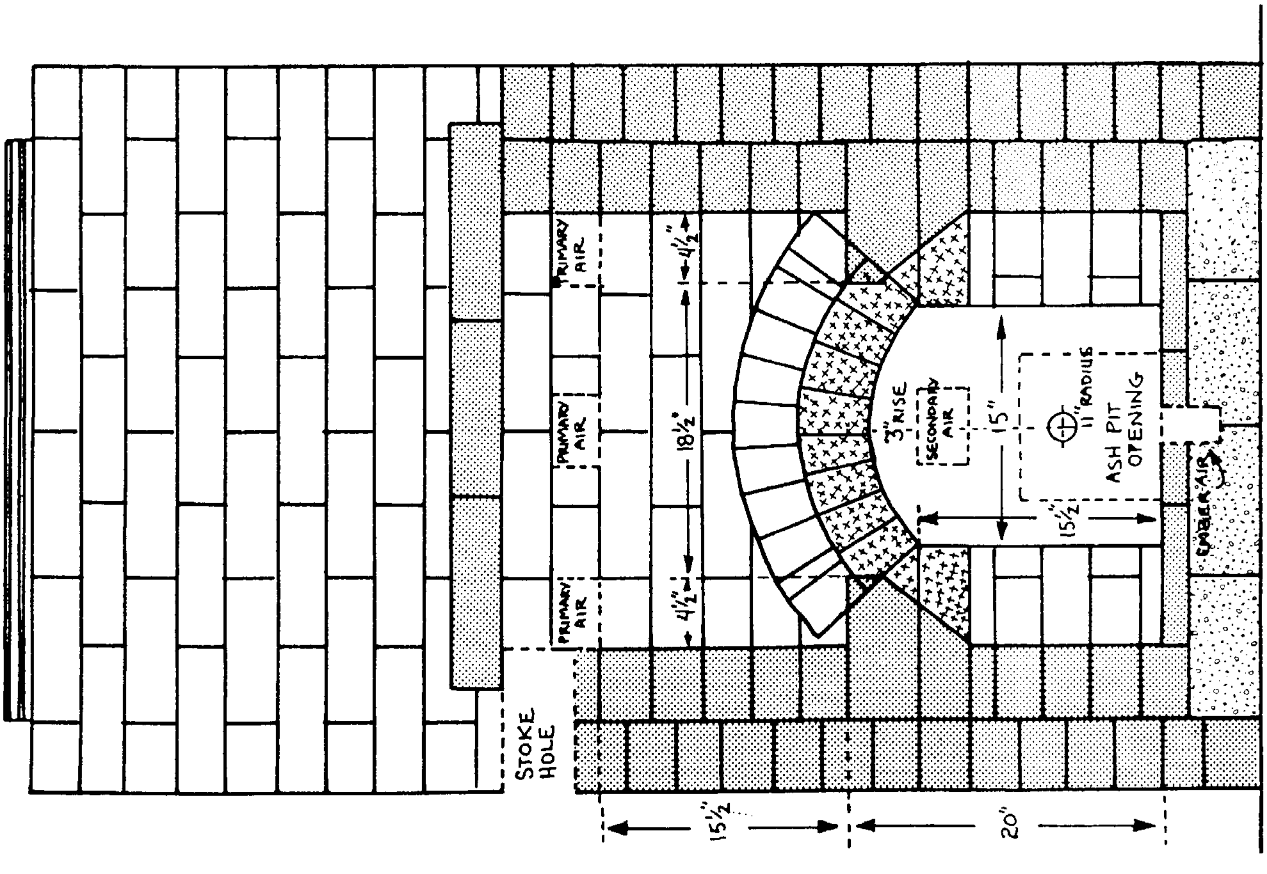
Handled properly, and with suitable fuel, this kiln will achieve 1300°C under reducing conditions with ease, and has the advantage of wide versatility, in that both firing and cooling conditions can be controlled as far as both speed and atmosphere are concerned; so far it seems to have adequately met the demands made on it as a training kiln.



SECTION A-A
(DOOR SUPERIMPOSED)



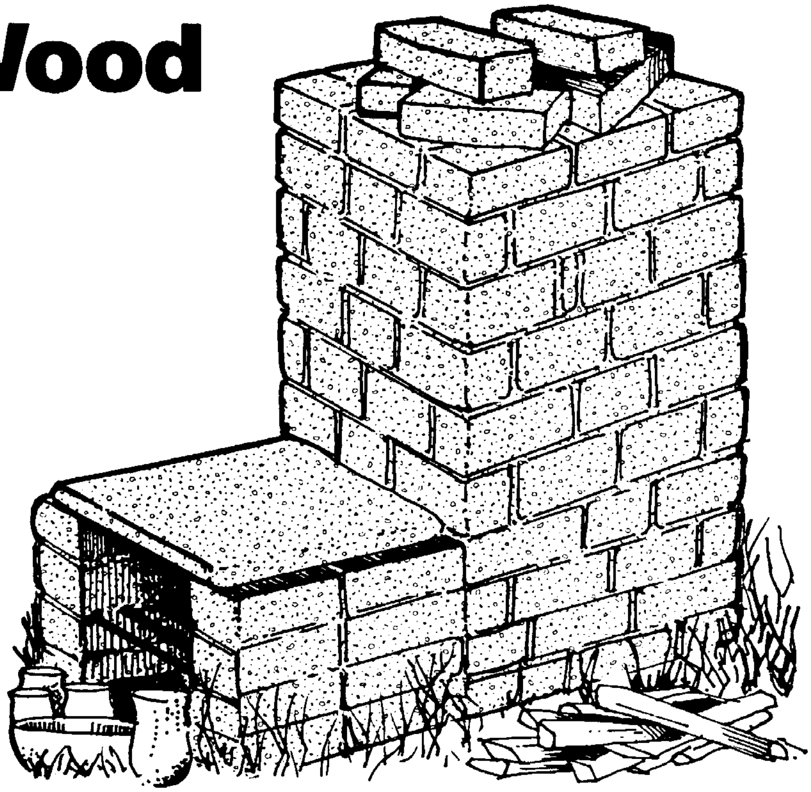
SECTION AT BAGWALL



SECTION THROUGH FIREBOX

A Simple Wood Fired Kiln

by Ivan Englund



Pottery can be made by students and potters without expensive electric kilns in a simple wood-fire kiln which is cheap, easy to build, and which will fire without undue effort to glazing temperature in a short time. The kiln described here needs only 100 bricks and these can be firebricks, commons, second-hand, or even broken ones. It can be erected in about an hour. It will fire biscuit in about three hours and glaze in two hours, burning wood in the form of packing cases, timber off-cuts, broken furniture, etc. The results will be real and honest pots of the low-fired earthenware or raku type. This kiln and the glaze have been used as a basis of teaching at summer schools as well as during normal classes.

The Kiln

The kiln is a simple updraught type and needs about 100 bricks. A flat section is selected and raked level and on this a solid square of bricks, 2½ bricks square, is laid on the flat, with two projecting arms to the front. A second course of bricks on the flat is now laid on the projecting arms and the outside of the square, leaving the passage from fire box to kiln open. Across the projecting arms, metal rods are laid to act as fire bars. Around the edge of the square, bricks are laid on edge to a height of seven bricks, using clay slurry as a bond, making sure that the bricks are tapped down to give thin joints. The fire box is built to the front on the projecting arms, two bricks long by two bricks high, still leaving an opening between fire box and kiln. A fire box cover is placed over this space. This could be a clay slab of some sort, if available, but a sheet of steel plate will be easier to get and is just as good. Even a piece of galvanized iron will do temporarily for a few firings, if you can't wait. Underneath the fire bars, the earth should be excavated to a depth of at least six inches, for there is a big build-up of charcoal and this will save some raking. Inside the kiln chamber are two bricks on edge and upon these rests the first or lower shelf.

The Kiln Furniture

All firing is done on open shelves. These are 9" x 9" and can be of fire brick, silicon carbide, clay floor tiles, or brick simply sliced through with a bolster. In this case, two halves make up a shelf. Shelves can be made by the potter with grogged clay. The shelf supports can be pieces of cut brick, or little clay cylinders thrown or hand rolled.

Setting

The pots are set in the kiln from the top. The lowest shelf is placed in position and packed with pots. The next shelf is arranged on supports and packed, and so on until the kiln is full. With the sizes given, there will be about 3" of space all around the shelves to allow plenty of space for the flames. The top is partly closed in with loose bricks across the corners, leaving a space about 4" x 7" for smoke and flames to emerge. If more space is needed to accommodate a few more pots, a couple of extra courses of bricks can be added with no effect on the performance of the kiln.

Firing

In firing pottery, there is one rule that cannot be broken – and that is **fire slowly**. At the start, a very small fire is lit at the very entrance of the fire box and is kept small until the water is driven off the pots, taking about an hour. Do not allow the flames to impinge on the ware at this stage; if an ominous "pop" is heard, the fire must be raked out quickly and continued slowly. When possible, the fire is gradually increased until the firebox is two-thirds full of brightly burning wood and the flames are perhaps 9" out of the top. Very exciting!!! A bright fire is maintained until an even red temperature is achieved all through the kiln. This can be checked by sight, for it is possible to look into the kiln – but watch the eyebrows. Cones 015A (820°C) and 010A (900°C) may prove useful. When the right temperature is reached, the fire is allowed to burn out; the front of the firebox and the top of the kiln are closed with loose bricks to exclude cold air, and the kiln is allowed to cool naturally. While the kiln is firing, the ash pit should be kept clear of ash to allow a good flow of air through the fuel. The only difference in glaze firing is that the early slow fire can be eliminated and the glazes can be checked for melting at the top. Light, quick-burning wood such as packing cases, etc., must be used. Large and heavy pieces of timber should be avoided, since what is required is a quick fire, especially in the closing stages. The fire should be clean and bright at all times.

Because the kiln is bonded only with clay, it should be covered from the weather.

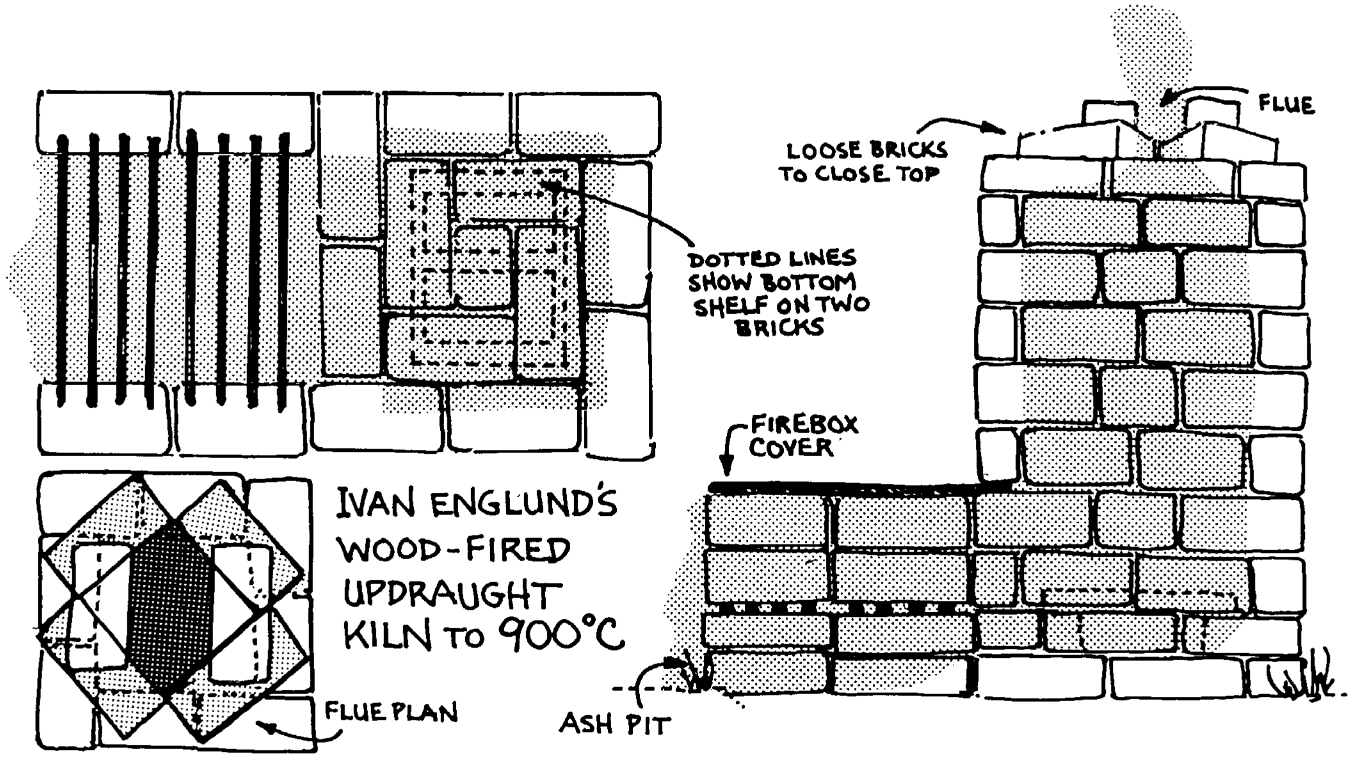
The Clay

In this type of firing, the clay is subject to considerably thermal shocks and while almost any clay can be fired with care, it is better to prepare special clay for this purpose. The addition of about 25% to 33% of grog or sand to the clay will make a suitable open body for this firing technique.

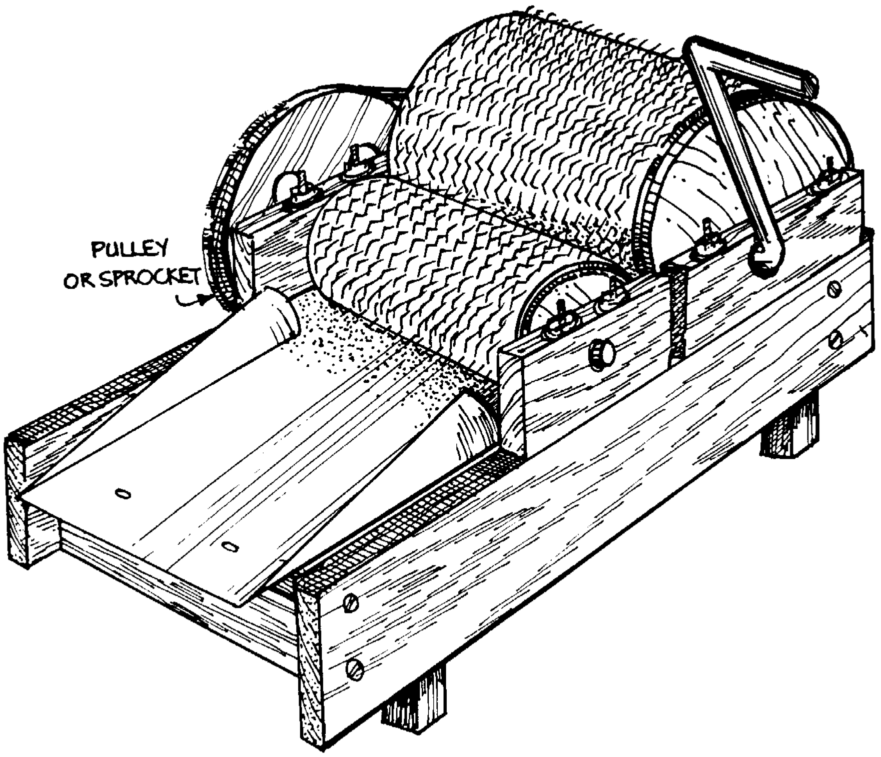
Conclusion

This kiln and glaze works very well at 900°C and there is a terrific amount of sheer fun to be had learning about pots in this basic and fundamental way, but let me conclude on a note of warning. All your expert and non-expert friends will tell you that this kiln can't work because it is too simple, or that you can improve it by dripping oil, or it will be better fired with coke – or coal – or bottled gas, or that if you keep the fire going long enough you will get stoneware, or you must have this or that, and so on and so on. Don't take any notice of any of them. Have a little faith in me and try it **exactly** as outlined here. I guarantee it!

Further experiments have been made: By overflowing the fire-box with wood, the atmosphere in the kiln became smoky and deficient of oxygen. This **reducing atmosphere** on glaze painted with copper oxide gave good pinks and reds. Salt glaze: Pots were placed in the kiln and brought to full heat in the normal way. Common salt was then thrown into the fire-box in small handfuls with the flues closed. After a minute or so, the flues were opened, the fire built up, and further salt thrown in. About 2 lbs. of salt was used and the salting was kept up for about one hour. Results were very encouraging and no doubt further experience with this kiln could give more uniform results.


LOOSE BRICKS TO CLOSE TOP
FLUE
DOTTED LINES SHOW BOTTOM SHELF ON TWO BRICKS
FIREBOX COVER
IVAN ENGLUND'S WOOD-FIRED UPDRAUGHT KILN TO 900°C
FLUE PLAN
ASH PIT

A Carding Machine



This portable device permits carding wool or cotton in a manner which is not only far faster and more efficient than hand carding, but also much easier – a child can operate the machine. The capacity of this device is approximately three pounds of wool per hour.

Tools & Materials

Wood saw
Screwdriver
Metal drill 1/8" diameter
Wood drill ½" and ¾" diameter

Soft wood, leather, wire, metal rods, ¼" bolts and nuts, tacks, flat head wood screws and 16 gauge sheet metal. The exact amount of each is not mentioned due to the fact that many substitutes are available. Look over the plans and develop a list of materials based on your own resources.

Construction

Frame assembly – The frame is really a rectangle as shown in Fig. 1. Drill the holes as straight as possible where indicated.

Outlet tray – The outlet tray is made of heavy gauge sheet metal (12-16 gauge) and is cut to the dimensions shown in Fig. 2. The lower part of Fig. 2 shows where and by how much the tray is bent to shape. The two 1/8" dia. holes are for subsequent mounting to the frame. Bevel the corners 45° and to about 3/8" across the face of the bevel.

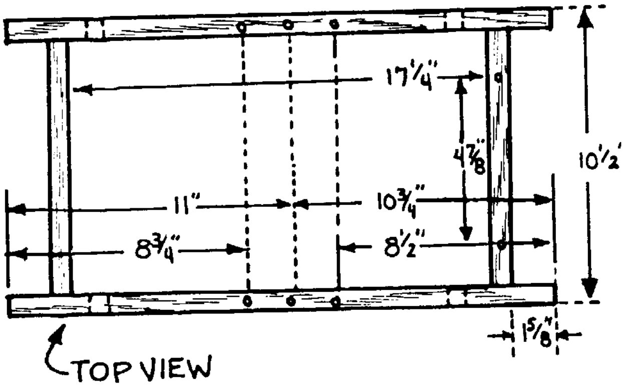
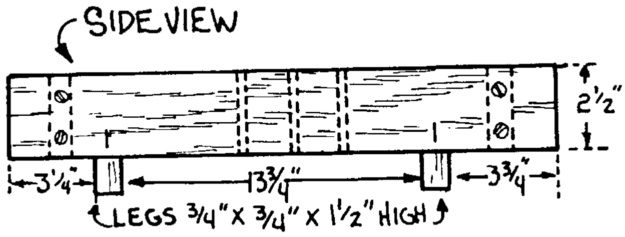


FIGURE I FRAME
3/4" THICK STOCK
3 CENTRE HOLES – ¼" DIA.
2 END HOLES – ⅛" DIA.



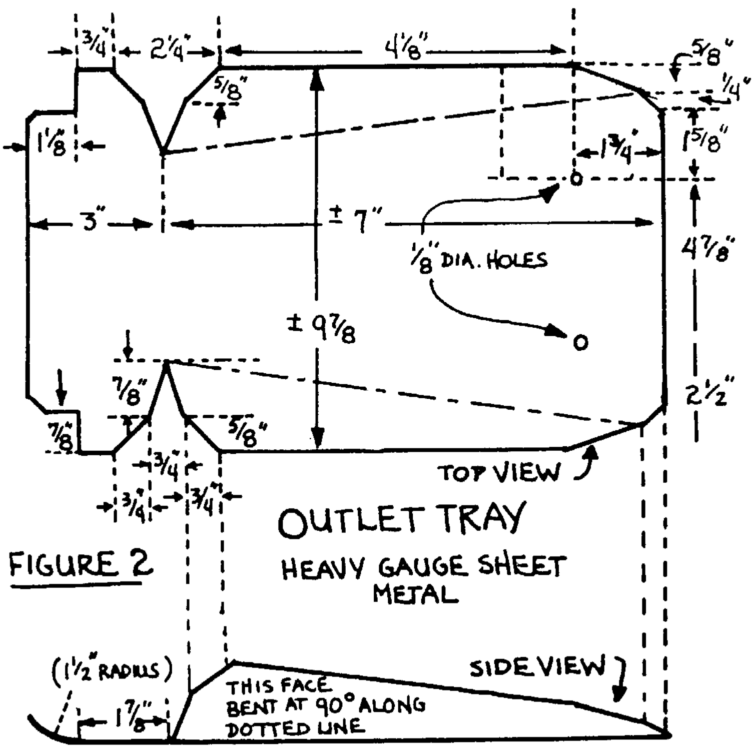


FIGURE 2

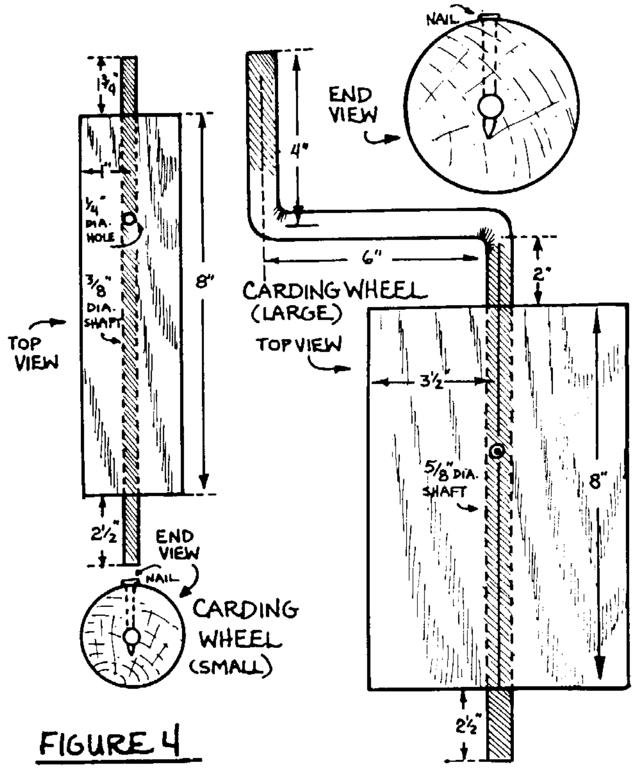


FIGURE 4

Bearing supports (Fig. 3) – Of the two sets of hardwood bearing supports, the larger is slotted to permit eventual adjustment of the gap between larger and smaller carding wheel. If you have the material handy, the bearing supports can be made a good deal more durable by providing bushings for the 3/8" and 5/8" shaft holes. Take care to fit the bushing (brass tube, G.I. pipe section or other) tightly into the holes in bearing supports.

Large and small carding wheels – These are soft wood cylinders of the radii indicated. The ¼" hole shown is for securing the wood cylinder to the wheel shaft. Drill the hole deep enough to pass through the cylinder and the shaft, then tap a nail of suitable length to permit a secure anchor in the cylinder. Cylinders are then wrapped with wire studded leather strips (i.e. cards) which are tacked in place with ¾" - 1" nails. These nails should be about 1" apart and located along all edges of each leather strip. Note that the metal shafts for the two wheels are of different lengths and diameters and the larger shaft should be long enough to permit the forming of a crank at one end as in Fig. 4.

In making the leather cards the wire studs are inserted into the leather strip through perforations made with a small nail. The wire studs are to be set in from the inside of the leather "tube" at 1/8" spacings. This is accomplished by overlapping successive rows. The teeth should all be bent in the same direction. Make the card for the larger wheel 7 x 3.14 or 21.98" long and the smaller card 6.28" in length.*

*These wire studded leather cards are quite difficult and tedius to make. An alternative is to order a replacement belt from a company such as Made-Well Manufacturing Company, Sifton, Manitoba, Canada

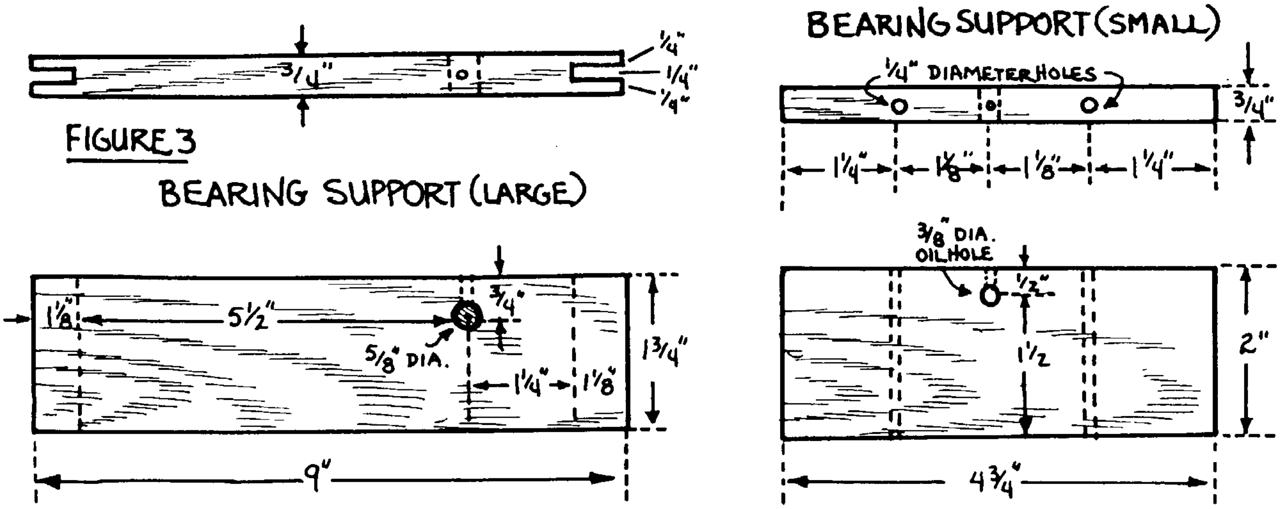


FIGURE 3

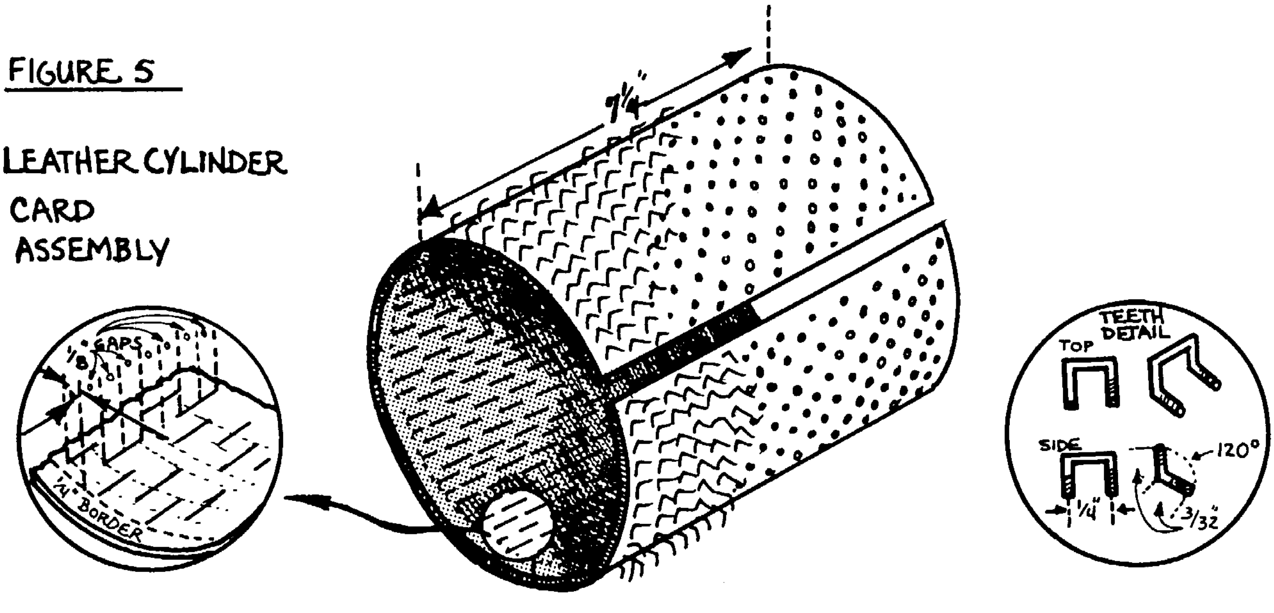


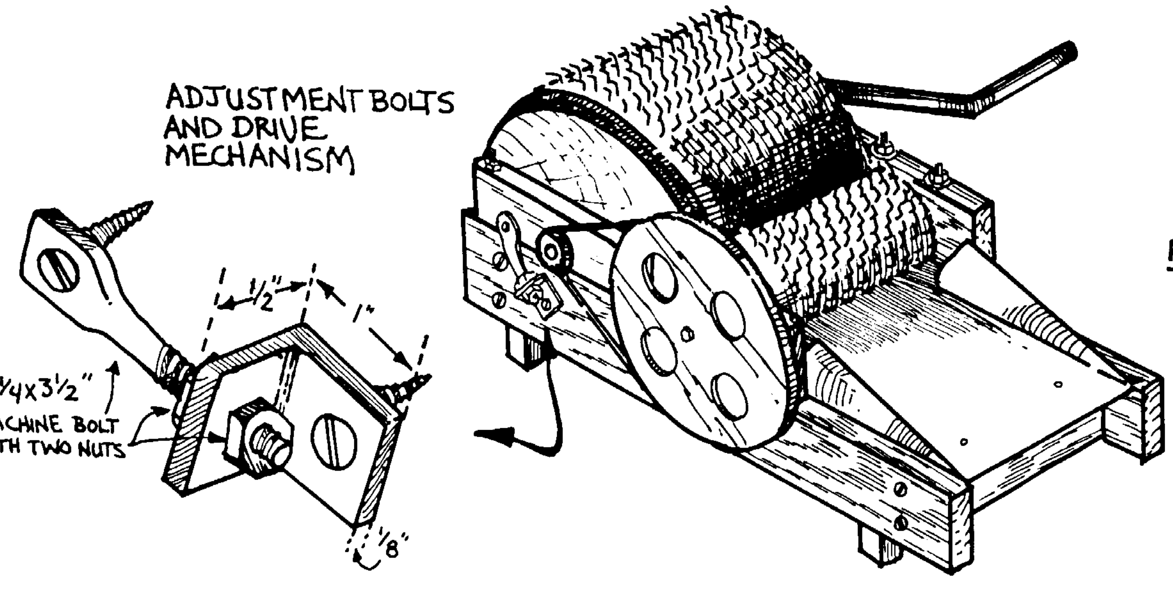
FIGURE 5

LEATHER CYLINDER CARD ASSEMBLY

Adjustment bolts, drive mechanism and final assembly – The drive mechanism of the assembly is attached to the longer straight protrusion of both carding wheel shafts. Note the direction of the teeth. General variations of drive mechanisms could be used but one of the best would be a non-slip arrangement utilizing bicycle chain and sprockets. See Fig. 7 for details of the bicycle chain drive. The ratio between the pulleys is to be 1 to 6, with the large carding wheel turning six times for every one revolution of the small carding wheel.

The carding wheels are adjusted by means of two brackets as shown in Fig. 6. Flatten the head of a ¼" bolt, bend it off to one side and drill the flattened head out for the result shown. The adjustment bolts are mounted with two 1" wood screws in the approximate position shown. The sheet metal outlet tray is as shown in Fig. 2, provided with two tabs which are to be fitted between the bearing supports for the small carding wheel and the frame. The curved portion fits under and around the lower portion of the small carding wheel. Note that this curved portion should not come into contact with either of the carding wheels. In assembling the carding wheels, use flat washers as necessary to insure good alignment and prevention of sideways play of the shafts with respect to the frame.

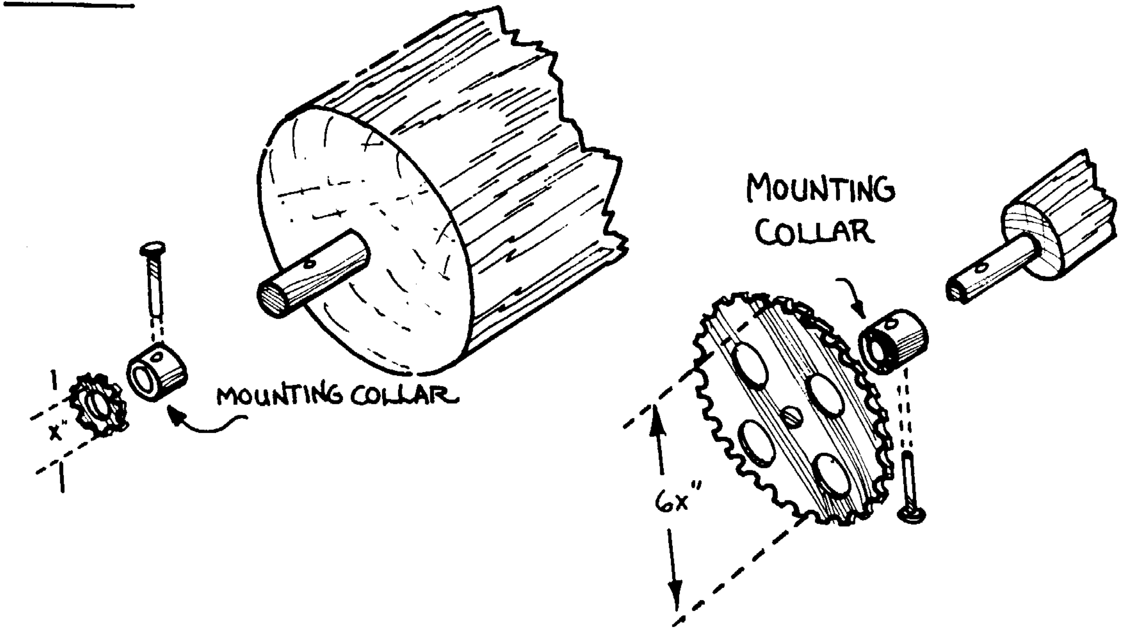
Chain drive mechanism details – Mount sprockets to shaft by any means available. Weld sprocket directly onto shaft or bolt sprocket onto a mounting collar (hardwood or metal) which could be fixed onto shaft in a manner similar to the method used for fixing the wood cylinders to their shafts (see Fig. 4). If a standard large bicylce sprocket is used for the small wheel it may be necessary to make your own small sprocket. To do this, first determine the required diameter of the smaller sprocket by dividing the diameter of the larger sprocket by six. Bear in mind that the spacing of the teeth will have to be the



ADJUSTMENT BOLTS AND DRIVE MECHANISM

FIGURE 6

FIGURE 7



same on both sprockets. If this spacing cannot be maintained with the 1 to 6 ratio, it will be necessary to inincrease or decrease the diameter of the smaller sprocket. Increasing or decreasing the diameter one unit will increase or decrease the circumference 3.14 units.

The best way to make such a sprocket is to draw the full size sprocket on paper with a compass etc. Cut out the finished drawing and fix it onto the 1/8" thick metal plate, then proceed to cut the form out of metal. Finish the task by filing the teeth to the shape of those on the large sprocket. Presuming that you've gotten over this hurdle, the final step is to attach the bicycle chain of suitable length.

Operation and Maintenance

To card with the machine, the greatest of care must be taken not to put in tangled or matted wool caused by improper washing, as this will bend the wires so that the carding material will be unfit for use. If wool is matted it should be teased. If it is washed properly it does not need to be teased.

Washing of Wool – Wool fibre is covered with scales; heat opens them, cold closes them. Causes of matting: sudden opening and closing of the scales, caused by varying temperatures, also rubbing and twisting will cause matting. Select a bright sunny day. Set up several containers of warm, **soft** water. Use good soap flakes, and half as much washing soda. Divide a fleece into about ten parts. Put one of these parts into the first container. Press it up and down gently with a hand vacuum paddle, plunger, or with the hands, and then squeeze out the water. A loose wringer may be used. Then do the same in the other waters, rinsing the last. **Do not twist, pound, rub or pack the wool and do not wash too much at one time.** Wool must not be washed in a washing machine or it will mat. The wool should come out of the water in one piece, the same as it was before washing.

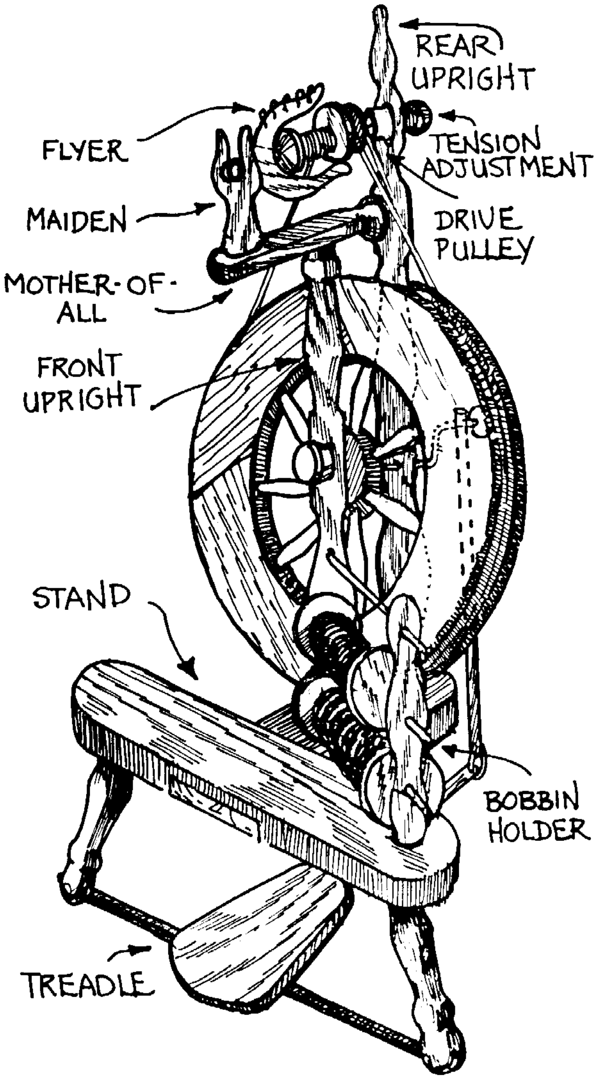
Another method is to place a fleece of wool in a tub of **soft** water. Make good suds with warm soft water. Put the wool through several waters, using a little wool at a time. Use a quarter of a cup of coal oil in the last water soaking. This will make the wool fluffy. Many persons living near streams wash wool there with good results. Some remove the bulk of the dirt at the stream and then finish washing with warm water. Dipping the sheep before shearing is a good custom. The wool is cleaned and the oil retained. When the wool is to be used at home this should be done when possible.

Operation of carding machine – Feed the wool in lengthwise so that it will not get broken up while cranking the large wheel in a direction away from the feeder tray. Do not feed too much at one time. When the wires are about full, cut through with scissors, take a piece of cardboard about 1" wide and 8" long and commence to roll the wool on the cardboard strip away from the feeder, while turning the drum backwards toward the feeder trays, until the wool is all on the cardboard. The wheels should barely touch, but exact clearance will have to be determined by experiment with the type of wool or cotton in your locale.

Adjustment and maintenance – After the carding machine has been used for some time it may be necessary to move the drums a little closer together. You will notice two small slots on each side. Loosen the nuts in these slots and slide the big drum closer by adjusting the tighteners (adjustment bolts) which are located on each side near the front of the machine. The tighteners each have two nuts which can be tightened. Lubrication with a heavy oil and cleaning of the bearings of cotton or wool fibers is all that will be necessary to maintain the machine for long service.

A Parlor Spinning Wheel

by Mike Nickerson



Confronted with many needs that must be filled in order to survive, the majority of us find ourselves dependent on a system that is beyond our control. The problems which are ailing that system seem likely to grow. If we are not to suffer with this ailment we must develop the tools and skills to provide directly for our needs. Such was the inspiration that led to the translation of a sketch in **The Joy of Spinning** into a working parlor spinning wheel. I will attempt here to describe the procedure by which one of these wheels can be made.

The Wheel

The first step in this procedure was to cut a template out of **masonite** with an 18" outer diameter and a 12" inner diameter. The wood used to make the rim was finished 1" x 6" maple. The finished measurements were ¾" x 5½". Two 6' pieces were cut into eight pieces 13½" long (save the ends for making **bobbins** and **hub**). The eight boards were then glued and clamped to make two pieces (Fig. 1) which fit together to make a square. Be sure to remove dried glue that would interfere with the boards fitting snugly. The closer the fit, the less patching later. With the two halves ready and fitted together, the wheel was drawn using the template, and it was cut out on a band saw. The hub was made by laminating two four inch by four inch pieces of the finished maple and cutting out a 3½" circle from it. It is necessary to have a lathe that can turn an 18" wheel off its end or, as I ended up with, a 5/8" shaft held over the edge of the table by two mounted bearings and a large pulley to attach to a smaller one on a power source (Fig. 2). A suitable **face plate** is then attached to the hub and the circumference rounded, trying to keep the edge 90° to the face. Before

FIGURE I

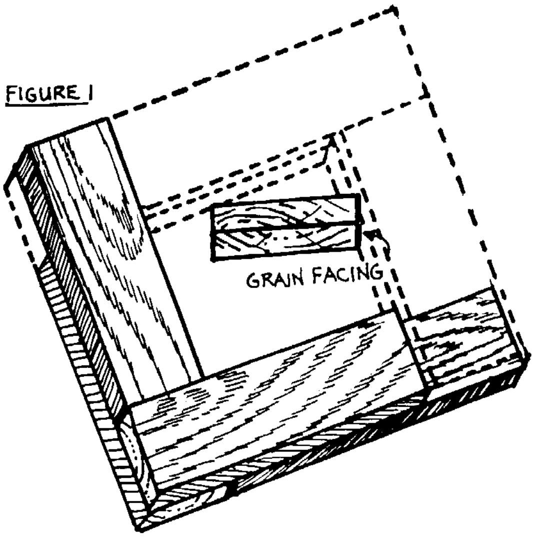
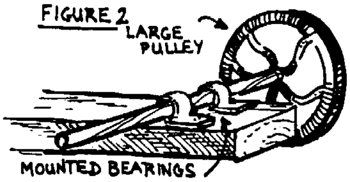


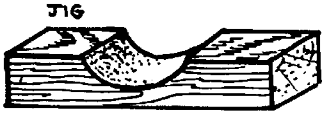
FIGURE 2



taking the hub off the lathe, mark the true centre for drilling. Also mark the hub so that the faceplate can be replaced in the same position. Drill the centre hole with a 3/8" bit making sure that the press is working at 90 degrees to the supporting surface. I decided to use seven spokes and marked the piece of masonite from the centre of the rim template off into 51.4 degree sections. These don't have to be exact, just as close as possible. Concentric circles on this template will help centre the hub for marking.

Once the holes are located, marked, and a starting hole made, a jig (Fig. 3) can be constructed by cutting in a 2" x 2" (with a band saw) a semi-circle the same diameter as the hub. The jig is then clamped to the drill stand so that when a spoke hole marker is directly up it is right under the centre of a 7/16" drill. Drill the seven holes an inch deep or so and return the hub to the lathe to round the corners and finish with sandpaper.

FIGURE 3



The Spokes

The spokes are the next step, but first some general procedure for preparing a piece of wood to be turned. Both ends need to be marked for their centres. On a square piece this can be done by drawing two lines crossing from the corners. On one end, lines at right angles to each other should be cut 1/8" into the wood. This is to ensure a solid grip on the turning end of the lathe. Both ends should then be drilled with a bit slightly smaller than the points on the lathe. Finally the corners should be taken off, leaving a roughly eight sided piece. This final step can be done either with a chisel or by setting a table saw at 45 degrees and adjusting the guide so that just the right amount is removed (Fig. 4). The spokes can be made from a piece of rough 1" x 6" maple. Start with a piece 2' long. The extra will be used for the flyer later. Prepare seven pieces 6½" long and turn to the dimensions shown (Fig. 5).

Measurements can be made consistent by using calipers or thin open-end wrenches. After trimming the ends, assemble the spokes with the grain perpendicular to the hub. If they do not fit tightly, glue them in. The rim is then prepared by clamping it together in a vise, (If using a metal vise, use pieces of wood to protect the wheel surface.) Shape and smooth the inside rim with files and sandpaper.

To assemble, the rim was laid out as one piece and the hub with spokes was positioned so that none of the spoke holes corresponded with the joints yet to be glued. The rim was marked where each spoke touched. One spoke and mark were identified so that it could be realigned. The rim was centre punched where these marks, when extended, crossed the centre of the wheel. They were drilled with a ½" bit to receive the spoke ends. Fit it to make sure the holes are deep enough. With all well, glue and clamp the rim (not the spoke ends).

Wheel Alignment

After drying, the wheel can be aligned by putting it on the lathe and turning slowly by hand. Compare the rim with a stationary object. Where the rim moves too far in, out or side to side, adjust the spokes where they meet the rim. Sometimes this requires whittling the hole or the spoke, sometimes it requires shims. Work at it until a minimum of movement is achieved. An eighth of an inch is not critical but perfection is desirable. Finally, glue is carefully worked into the joints so as not to disturb the alignment. When the glue is dry, the wheel is ready to turn. Since the outer rim of the wheel is almost 5' in circumference and turns a couple of times a second, the cutting must be done very carefully. If chisel movements are not very slow the point can get caught in end grain. When this happens the grain pulls out, making a rough portion that is more likely to catch the chisel again.

The entire rim must first be evened and then two grooves cut as in Fig. 6. Use files and sandpaper to smooth the surfaces and to round the corners. To finish the wheel, use a mixture of white glue and the sawdust of the wood used. This mixture can be worked into joints, gouges and the screw holes from the face plate. When the glue dries it can be sanded to a smooth continuous surface.

The Stand

This piece starts out with two lengths of 2" x 4", one 16" and one 14" long. I used B.C. fir for the grain, but any wood that is unlikely to warp can be used (Fig. 7).

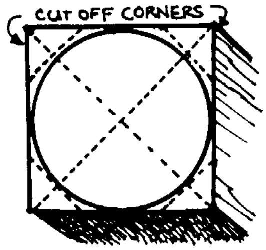
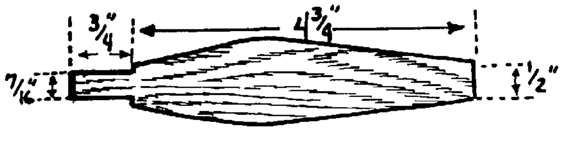


FIGURE 4

FIGURE 5 - SPOKES



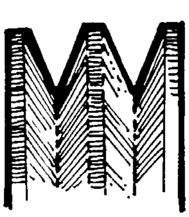
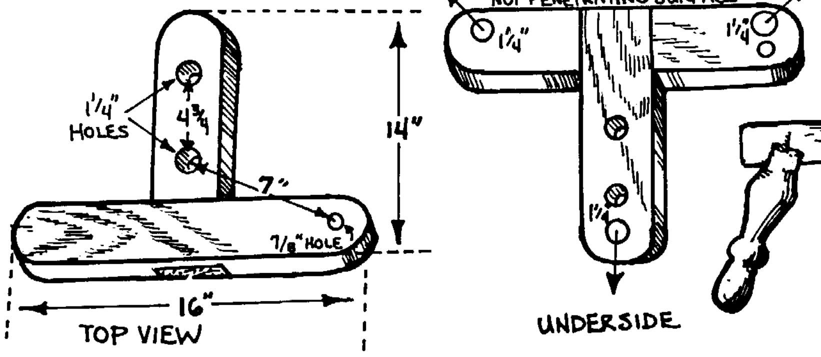


FIGURE 6

FIGURE 7



The Legs and Frame

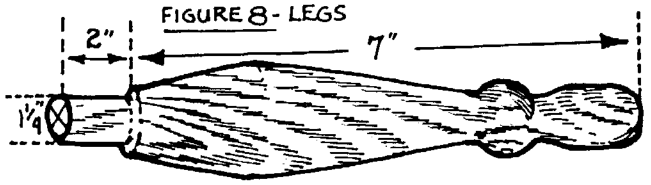
The next eight pieces are all made from 2" x 2" or the same wood as the stand. The pieces needed are:

Legs	3 pieces	10" long
Front upright	1 piece	24" long
Back upright	1 piece	33" long
Mother of all	1 piece	13" long
Bobbin holder	1 piece	13" long
Maiden	1 piece	7" long

All pieces are prepared as in the section on spokes.

Legs (Fig. 8) – All dowels should be slightly larger than the holes so they can be shaped for a tight fit. The end of the legs should be round so that they fit the floor and so that the treadle can be attached conviently. Other shaping is arbitrary.

FIGURE 8 - LEGS



Front Upright (Fig. 9) – The hole for the axle is perpendicular to the grain. The 7/8" section ¼" to 3/8" deep is for a bearing made of bone. The rest of the hole should be large enough that the axle will turn freely.

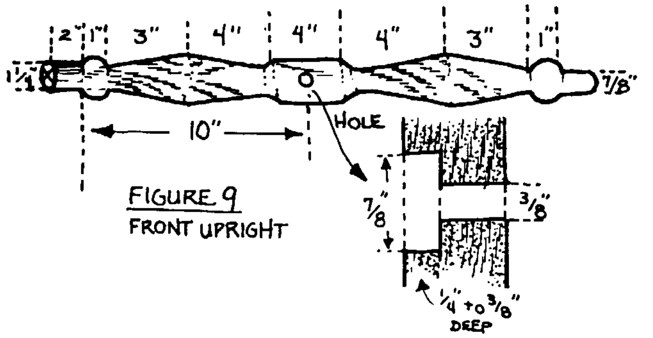


FIGURE 9
FRONT UPRIGHT

Rear Upright (Fig. 10) – The 7/8" hole for the mother of all should not penetrate the back of the piece. The tension adjustment slot is made by drilling a row of holes slightly larger than ¼" and then joining them together with a chisel and finishing with a file.

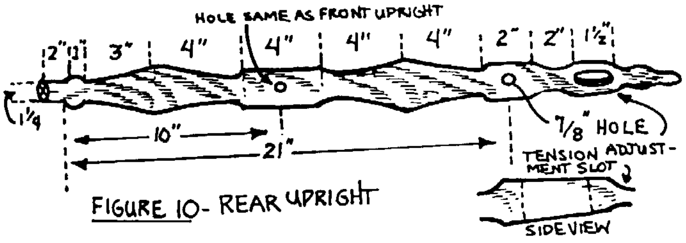


FIGURE 10- REAR UPRIGHT

Mother of All (Fig. 11) – The top portion of the long section needs to be cut flat on a band saw or with a chisel.

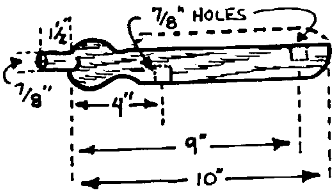


FIGURE 11 - MOTHER OF ALL

Maiden (Fig 12) – Both sides of the top want to be cut flat with the grain. Then a 5/8" hole is drilled perpendicular to the grain and is cut on a band saw so that a 5/8" pipe can be lowered in.

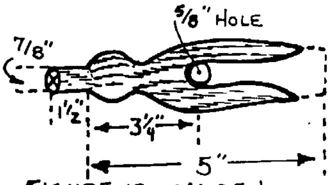
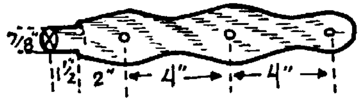


FIGURE 12 - MAIDEN

Bobbin Holder (Fig. 13) – The holes should be big enough for a coat hanger wire to slide easily into. When assembled, the lengths of coat hanger, bent at one end for a handle, go through the holes and across to the front upright, to support extra bobbins.

FIGURE 13 - BOBBIN HOLDER



Bearings

Three bearings are used in this design. The two bearings for the uprights have a 7/8" outer diameter and a 3/8" inner diameter. These can be made by cutting the side off of the narrow section of a bone and drawing the necessary disks. The centre needs to be clearly marked and drilled before the pieces are cut. (The cut pieces are hard to hold for drilling.) The outsides are then roughly cut on a band saw and shaped with a file or on a belt sander until they fit snugly in the appropriate hole. The other bearing is 5/8" outer diameter with a hole adequate to accommodate the end of the bobbin axle of the flyer assembly.

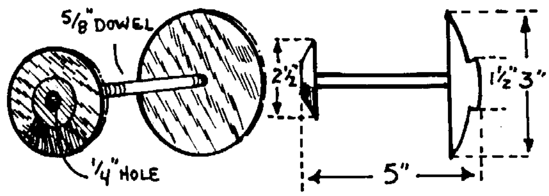


FIGURE 14
BOBBIN

Bobbins (Fig. 14)

The three bobbins are made from the same hardwood as the wheel. The dowel can be turned from 1" x 1" x 6" pieces. To get the hole centred, it is easiest to drill the 1" x 1" with a 6" bit. First make a 1/8" deep hole the diameter of the **dead centre** on the lathe. Then drill the main hole from the end drilled for the dead centre. I found it necessary to clamp the piece of a squared block with a corner on one side that the 1" x 1" fit into (Fig. 15). Since the drill press only had a 4" bite, I needed a shim that I could easily place under the jig to continue the hole. Before turning, saw a cross centred at the middle of the hole where it emerged from the piece. After the corners have been removed, the piece will fit on the lathe with the hole down the centre. The 5/8" dowel can then be turned. For the ends, mark appropriate circles on the leftovers from the wheel. Be sure to make the centre point clear. After the discs are cut out, drill the centre through with a bit slightly smaller than the points of the lathe. After one side is crossed with a chisel, the pieces can be turned. With some lathes it is necessary to improvise a tool rest. For the pulley notch, some wood can be cut away with a chisel, but I used a small size round file for the most part.

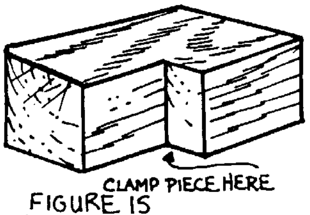
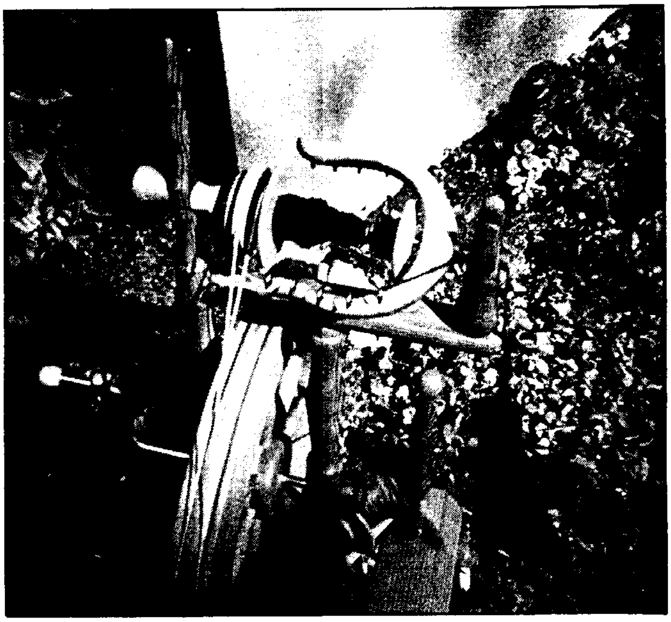


FIGURE 15



The less wood in the bobbins the better they will work, providing they hold together. After the turning is finished, drill the centre to 5/8" and cut away anything left over from where the lathe was attached. A belt sander is useful for this. The pieces can then be assembled. Since I finished the batch I did, it was recommended that the bobbins be fitted with leather bearings. These would be 5/8" outer diameter and ¼" inner diameter. Their purpose is to keep the bobbin from clicking on its axle while spinning.

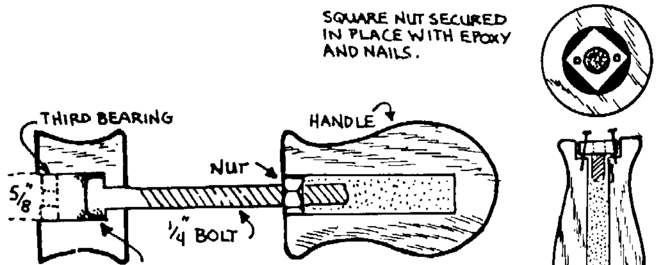


FIGURE 16 TENSION MECHANISM

Tension Mechanism (Fig. 16)

The part holding the bearing should be made out of hardwood. The bolt is firmly glued in with expoxy. The handle can be of any wood with the nut glued in and the hole drilled deep enough to receive the excess bolt. The length of the bolt can be determined by giving 3/8" or so beyond the widest point of the tension adjustment slot on the rear upright.

The Flyer Assembly (Fig. 17)

The orifice can be made from a 2¾ piece of 5/8" outer diameter pipe. The 3/8" diameter hole is about ¾" from the flyer end of the pipe. All burrs on the open end and

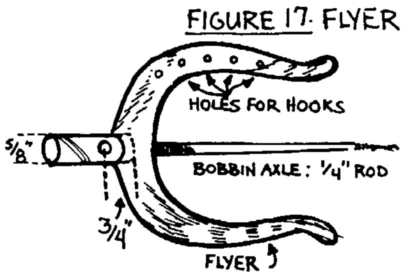


FIGURE 17. FLYER

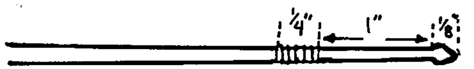


FIGURE 18 BOBBIN AXLE

around the holes must be removed and smoothed to prevent the yarn from catching. The bobbin axle can be made from a 9" piece of ¼" rod. One end needs to be turned (Fig. 18) for which a metal lathe would be optimal, but a wood lathe can be crudely adapted.

Turn a 2" 1" x 1" into dowel and cut it in half while still on the lathe. The saw marks will indicate the centre of each piece. Drill the dead centre end so that the ¼" rod will fit in. Then drill the live centre end and glue in a ¼" nut. With these adaptions, the 9" rod with a thread cut on one end can be turned. Cutting (possibly started on a grinder) should be done with metal files and finished with emery cloth. The part that rests on the bearing must be smooth or it will wear the bearing away.

The flyer must be shaped so that the opening encompasses the bobbin, but is not in the way of the strings. The point where the orifice and the axle attach should be at least 1" through.

It is important that the flyer be balanced. This can be worked out on paper by drawing one arm and folding it over. When shaping, saw squarely across the open end and cut along the outside edge. After locating and marking the centre point, drill a 5/8" hole ½" into the end. Take care to get it straight (check drill/table angle before starting). The 5/8" hole is then continued with a ¼" drill. After the holes are drilled the inside edge can be cut out and the piece shaped and finished with a rasp, file and sandpaper. Before assembling is the best time to drill small holes to receive guide hooks.

Before assembly roughly clean the parts of metal to be glued. The axle needs to be measured to the actual size of your maiden tension bearing set up, and cut so that it does not protrude beyond the flyer base. These pieces can then be glued together with epoxy and set to harden as carefully aligned as possible.

The Drive Pulley (Fig. 19)

I made this piece from one of the corners cut off when the wheel was shaped. The ¼" nut is to screw onto the bobbin axle, so the hole that continues must be large enough to accommodate the end of that axle. If the nut is in crooked the piece wobbles when it is being used.

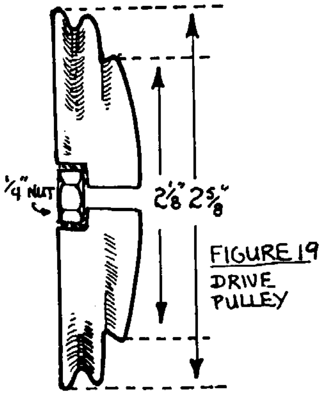


FIGURE 19 DRIVE PULLEY

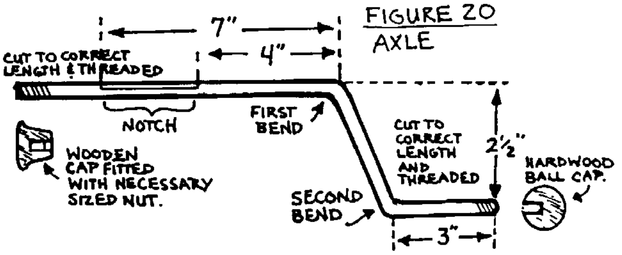


FIGURE 20 AXLE
7"
4"
CUT TO CORRECT LENGTH & THREADED
NOTCH
FIRST BEND
WOODEN CAP FITTED WITH NECESSARY SIZED NUT.
SECOND BEND
CUT TO CORRECT LENGTH AND THREADED
2 1/2"
3"
HARDWOOD BALL CAP.

The Wheel Assembly (Fig. 20)

The wheel axle can be made from a 17" piece of 3/8" rod. This is easily bent by putting a 3' length of pipe over the end and using its leverage. Be careful not to warp the section where the wheel will sit. The notch is for setting the wheel so that it is rigid with its axle. There are machines for making such grooves, but in their absence the job can be done with a rotary file and a drill press (Fig. 21). When the axle is bent, notched and burrs removed, it can be fitted and cut to length. The second bend should be directly above the end of the stand. The front end should be about 3/8" beyond the front upright. Both ends should be given 3/8" of threads. The axle is then put through the rear upright, a bearing, the wheel, another bearing, and the front upright. When the wheel is lined up with the drive pulley and the bobbin pulley, a small nail driven between the wheel and notch will fix it there. The front of the axle can be capped with a piece similar to the back piece of the

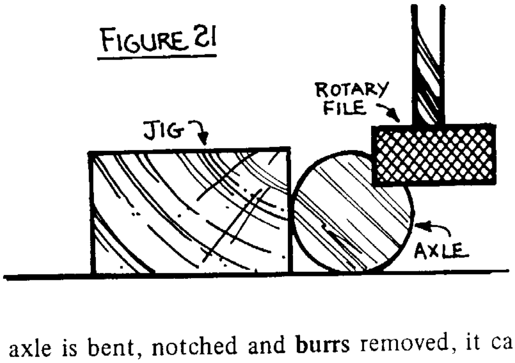
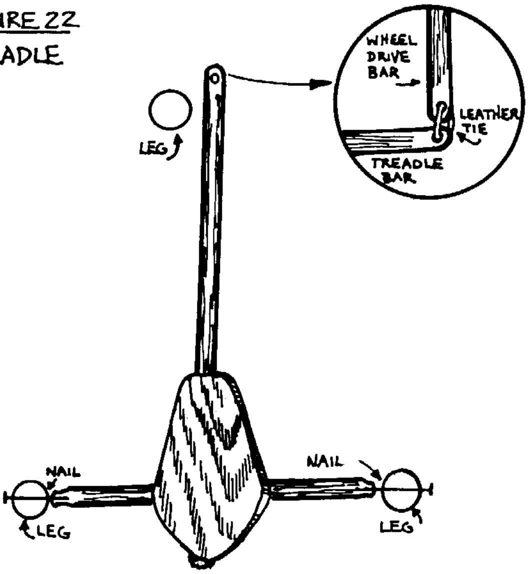


FIGURE 21

tension mechanism but with the necessary sized nut. After the treadle is attached, the rear end can be capped with a 1" hardwood ball with a hole slightly smaller than 3/8". This will thread itself when it is twisted on.

FIGURE 22
TREADLE

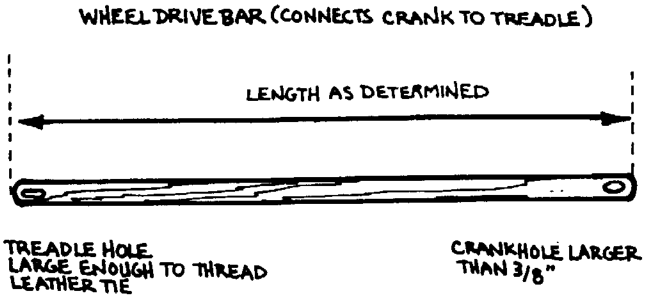


Treadle (Fig. 22)

The final thing to make, before yarn, is the treadle. I used pieces of branch with the bark left on for the connecting pieces, and masonite for the pedal. I have been told several times that the masonite is out of place, and if I do it again I will use a thin piece of maple. The piece connecting the crank to the treadle needs a hole for the crank larger than 3/8" so that it can move freely around.

The length of the wheel drive bar is determined to as follows. Drill the crankhole. Put it on the crank reaching toward the treadle bar. With the treadle bar one inch above the ground and the drive bar pulled towards it, mark, cut and drill the hole for the leather tie.

FIGURE 23


WHEEL DRIVE BAR (CONNECTS CRANK TO TREADLE)
LENGTH AS DETERMINED
TREADLE HOLE LARGE ENOUGH TO THREAD LEATHER TIE
CRANKHOLE LARGER THAN 3/8"

Stringing the Wheel

Take a fairly heavy string, wet it, and stretch it between two posts and let it dry. One length of string should go around the wheel, the drive pulley, the wheel again in the other groove and the bobbin pulley. The string should cross so that the one coming off of the drive pulley passes over the other without rubbing. Pull the string taut with the tension mechanism near its low point, but not so low that the hooks or flyer touch the mother of all. Mark both ends at their meeting point and cut ¾" to 1" longer than the marks. I found the string too fine to splice like rope, so I just fitted the unravelled ends together with the marks aligned, worked in a little glue that dries pliable and wrapped a thread around the join.

When all is done, the whole thing should be treated with linseed oil. A 3" piece of stove pipe wire with a small hook on the end should be tied on a string from the base of the maiden so that it is handy to pull yarn through the orifice to start spinning.

A final touch which I add in order to communicate my initial inspiration is putting the name Bakavi on the stand. Bakavi is a way of life where people working in community produce from what grows around them the necessities of their existence. Materials which are not regenerative are managed in such a way that they are not lost. The energy that is needed by the community is provided from the sun, the wind and other continuous sources. To become a part of such a living situation is my objective. Perhaps others so inclined can get in touch through this article.

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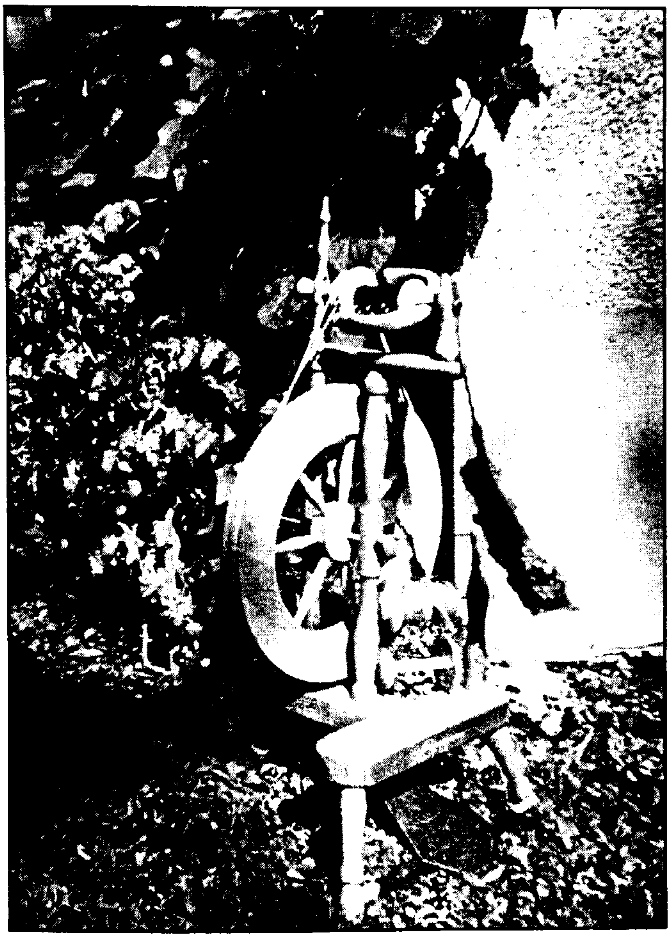
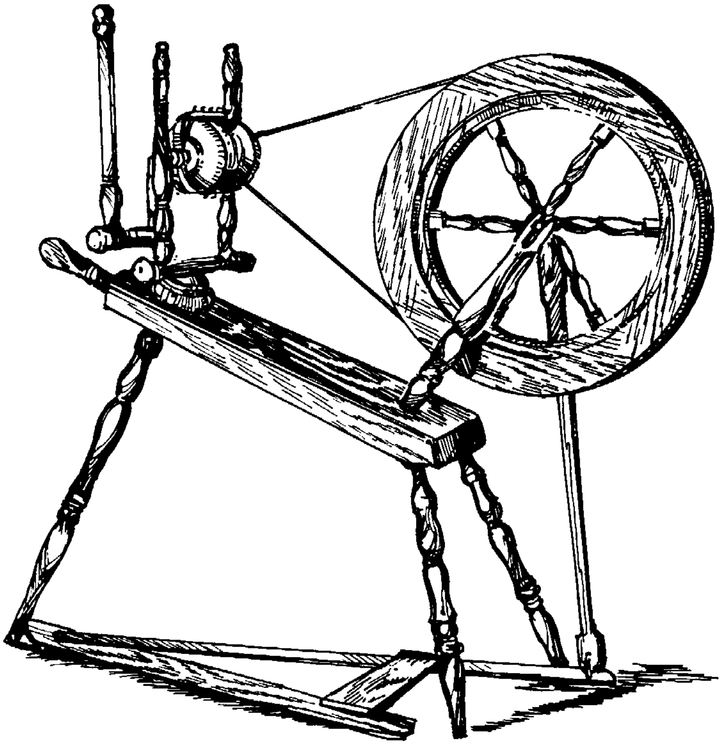
Station 'D'
Ottawa, Ontario



A Colonial Spinning Wheel



by E.M. Love

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Few people are fortunate enough to own a colonial wheel, but any handy person can make an excellent tool by following this article.

Most common hardwoods are suitable for material. Maple is perhaps the most desirable for the turned work, and oak or ash for the base, **treadle** and **pitman**. Glue up the wheel rim as a square frame from stock 1½ by 4¼ in. in the rough, the four pieces being 16 in. long. The ends are cut to an angle of 45°, as in fig. 1. Smooth one side and one edge of each piece for working faces, and gauge the ends with two lines, one 3/8 in. from the face; the other 7/8 in. for the sides of the **tenons** and **mortises**. Shoulder lines, 9½ in. apart, are scored with a knife square across the faces of the tenoned pieces, while pencil lines across the others limit the depth of the mortises. Rip the ends with the saw, splitting the line and cutting in the waste wood. Crosscut the shoulder, and chisel the mortise bottoms from both edges. Try for fit, apply glue liberally to all joining surfaces, and clamp up. Small clamps across the thickness of the joints will prevent wedging open. Set aside to dry until the turned work is done.

Rip 1½ in. strips from 1½ in. stock for larger spindles, and punch the centres of the ends with a nail. The illustration below fig. 1 shows a crude lathe driven by a washing-machine motor. The headstock is a piece of 2 by 4 inch wood, notched at one end to fit over the edge of another length of 2 inch material to which it is nailed. A 16 inch spike, driven through the centre 4 inches above the bed, forms a turning centre. The **tailstock** is like it, but left loose. The **tool rest** is a board of suitable width clamped in the vise. The **spindle**, drilled to fit the centres, and roughly rounded on one end to serve as a pulley, determines the distance between head and tailstocks. These, when clamped to the tool rest, form a rigid assembly.

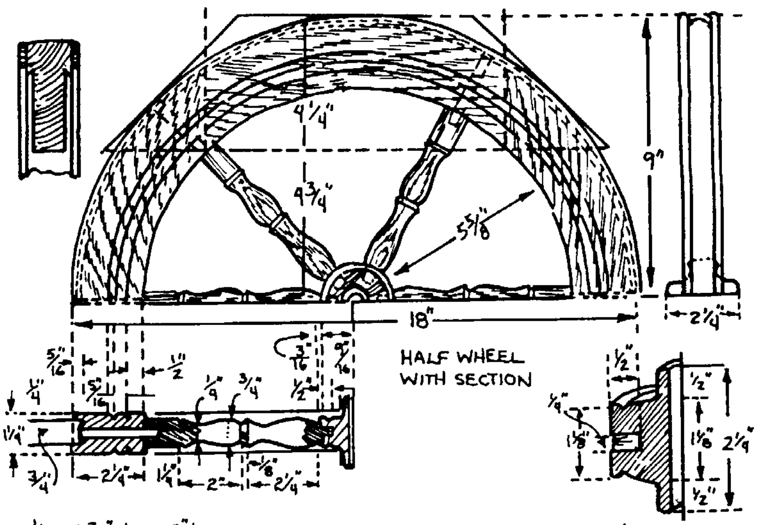
Bore a piece of hardwood to fit the motor shaft or collar, turning it to a groove diameter of 2½ in. Over this drive pulley, pass a round leather belt, or, lacking this, a piece of carpenter's chalk line woven into a chain stitch and knotted together for a splice.

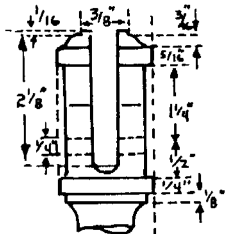
If a motor is not available, tie a 2 ft. length of inner tube to the ceiling for a return spring, with the belt tied to the lower end. Loop the belt around the spindle, attaching it to a 1 by 4 in. treadle, 3 ft. long and hinged to the floor at one end by two spikes driven through ¼ in. holes. With a little practice, very good turning can be done on this primitive lathe. A more elaborately designed foot-powered wood lathe is featured in **Cloudburst 1**.

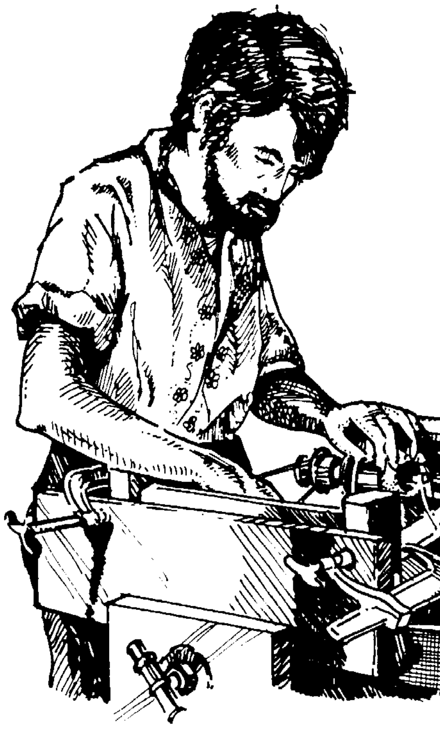
The average amateur has no turning tools, so shift must be made with common chisels. Sharpen a **gouge** to a razor edge. Fix the rest a little above centre. Lay the gouge on it, holding it level with the left hand close to the rest and steadying the handle with the right. Point the blade and incline its diameter somewhat in the direction of motion, taking a cut from one end to the other of the stick. A little practice will show how heavy a cut can be made without slipping the belt. Rough the spindle to the largest diameter.

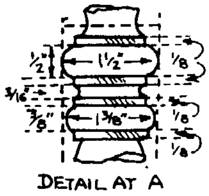
Figures 3 and 5 illustrate the legs. Cut the stock 1½ in. longer than the finished length, to allow for the pulley. Lubricate the centres with hard oil. When roughed to roundness, lay a rule on the rest, marking the divisions with a pencil while the piece turns. Work out the slender parts with the gouge to the finished diameter. If the tool is held well on edge in making the large **coves**, a shearing cut is obtained. Scrape the cylindrical portions with a ¼ in. chisel, holding it on edge to cut the shoulders and finishing with

FIGURE 1









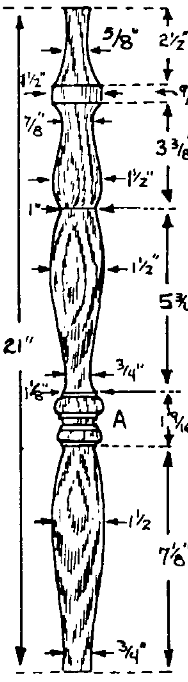


FIGURE 2

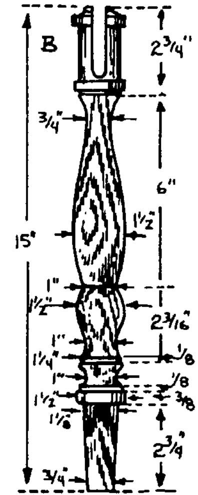


FIGURE 4

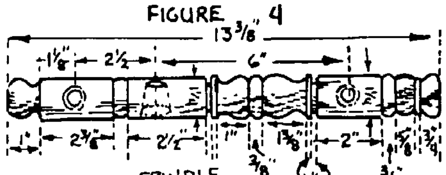
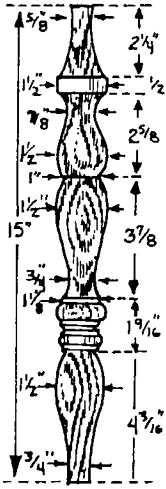


FIGURE 5



the blade held flat. For the beads, use the corner of the gouge, tipping the tool on edge as it nears the root depth. Cut the 1/8 in. coves with the tip of a rat-tail file. When the whole leg is shaped, smooth well with sandpaper. Lastly, cut to length.

Turn the two wheel supports, Fig. 2, in the same way. Rip the upper end of each through the diameter to a depth of 2-1/8 in. Parallel to this, 3/16 in. from it on either side, make two other cuts. Bore the bottom with a 3/8 in. bit. File the slots smooth.

Figure 4 details the spindle crossarm, which fits over the tapered nut above the turned base, carrying the two spindle supports. The smallest coves are lines made with a three-cornered file. Centering 1-1/8 in. from the left shoulder, bore a ¼ in. hole, 1/8 in. deep. Bore through the diameter with a ½ in. bit, and with a ¼ in. chisel and round file taper the small hole to meet the larger upper one. Another hole, centering 8½ in. from it, is bored and tapered parallel to it. A third hole, tapering from 5/8 in. above to ¾ in. below, centres 2½ in. from the first, inclining at the rate of 3-3/8 in. horizontally with a vertical rise of 6 in. Clamp the piece in a vise with the end holes properly inclined, as determined by a single stick thrust through and compared with a square held upright on the bench. The bit can then be held vertical in the usual manner.

Figure 6 shows a mortise. 1/4 by 1 in., in each spindle support, receiving a sole-leather spindle bearing. One leather is pierced with a 3/8 in. hole, while the other, carrying the tapered end of the spindle, is 3/16 in. Glue these in. Turn the tapers to such a diameter that the lower ends, solidly seated, project ¼ in. below the crossarm. Fig. 7 illustrates the **distaff** support. Four and one-eighth inches from the lower end, a 1/2 in. hole, 1 in. deep, carries the distaff crossarm, also detailed in Fig. 7. A ½ in. hole, 1 in. deep, centred on the cylindrical part of the crossarm, receives the distaff.

For tightening the belt, a screw, shown in Fig. 8, must be made. If an old wood clamp is available, the screw and nut may be turned from it; but if not, turn the screw from 1½ in. stock, with the threaded part ¾ in. in diameter. The end bearing is ½ in. through. The ¼ in. groove engages a wooden **key** in the base, to prevent withdrawal when the belt is slackened.

To get the **pitch** of the thread, build a **mitre box**, 3/4 in. wide, 1 in. deep and 4 in. long. With a **backsaw**, inclining 1/16 in. from the square in the ¾ in. width, make a cut, 3/8 in. deep, across the middle. Insert the end of the screw blank and cut a groove about 1/16 in. deep, turning slowly and moving the saw in two or three short strokes. Next, draw a pencil line midway between the grooves and whittle the thread roughly to shape. Smooth the groove with a saw file. A surprisingly accurate thread can be made in this way.

The nut, Fig. 8, having a square portion, 2-5/8 in. long, to slide in the base guide, is turned off on the corners to a diameter of 1¾ in. Bore a through hole 1-1/8 in. in diameter, centring 1¼ in. from the taper shoulder. Cast the threaded nut in plastic wood, as indicated below Fig. 8. Bore a 1½ inch hole through 2 x 4 inch piece, 1 inch from the end, and rip out the end. In the bottom, lay a thick bed of plastic wood. Press the oiled screw into it, mold the top and force the piece sawn out of the block against it. Cut the wooden mold to liberate the bushing, leaving it on the screw until well hardened. Afterward trim the **bushing** to fit the tapered nut and glue it in place.

The turned spindle base, Fig. 9, is best made from 4 by 4 in. solid stock, but if this is not available, glue two pieces of 2 in. stock together with the grain running at right angles, bore the hole and taper it, and drive it over the nut taper for an **arbor**. Turn to dimensions. It is recessed in the bottom ½ in. deep. The **bobbin**, dimensioned in the same drawing, is pierced with a ¼ in. hole, so as to turn freely on the spindle.

The spindle can be made from a 3/16 in. curtain rod, obtainable at most 10 and 15-cent stores. Split the end for ¾ in. bending the halves outward and back parallel, to give an inside width of 3/8 in. Cut the rod to 3¾ in., and file a taper, 1-5/8 in. long, on the solid end, reducing it to 1/8 in. Thread the rod for ¼ in. just above the taper where a nut sunk in the flier pulley engages. The eye bearing is a **ferrule** cut from the base of an oilcan spout and filled with plastic wood. When dry, fit the eye ends solidly and bore out the centre. The flier and pulley are also detailed in Fig. 9.

The flier is sawed from ¾ in. stock. Through a ¾ in. button, 3/8 in. long, and the slightly less than 3/16 in.

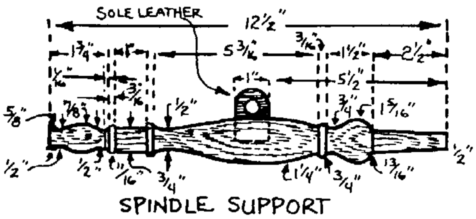
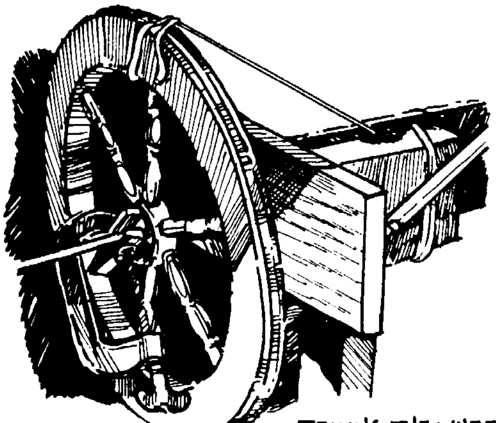


FIGURE 6



TRUING THE WHEEL

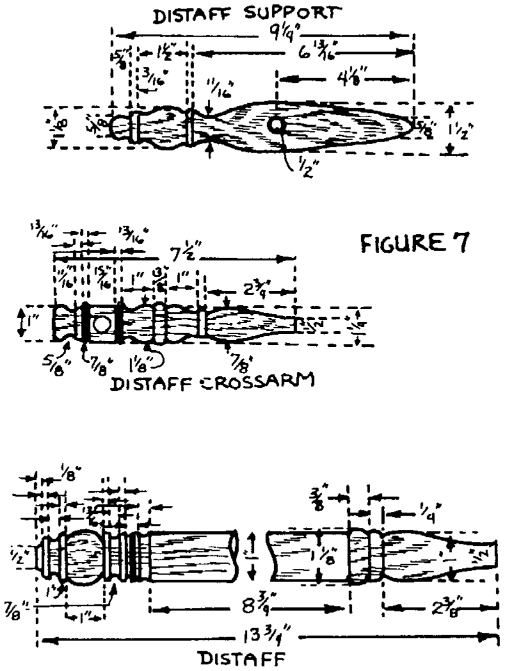


FIGURE 7

MATERIAL LIST

1 piece, 1½ by 5 in. by 5 ft., maple.
1 piece, 1½ by 8 in. by 4½ ft., maple.
1 piece, 1 by 6 by 12 in., maple.
1 piece, 4 by 4 by 12 in., maple.
1 piece, 2 by 10 in. by 2 ft., oak.
1 hinge pin from loose-pin butt, 2½ by 2½ in.
1½ doz. small steel hooks.
1 leather shoelace.

hole in the flier, the spindle is forced until the eye sinks into the button enough to grip it strongly. Screw nine small iron hooks into each flier arm, and, lastly, screw on the flier pulley. (In use, the flax or wool is fed through the eye bearing and looped over the hooks, with the end tied to the bobbin. The flier, rotating, twists the yarn, while the bobbin, having a smaller pulley and revolving faster, winds it up.)

Two small pins, shown in Fig. 11, are turned to hold the wheel axle in the slots. The axle is a 5¾ in. piece of 3/8 in. round iron. For the crank, bend a 5/16 in. bolt to an arc of about 1-1/8 in., hammering it to a thickness of 3/16 in. Near one end, drill a 3/16 in. hole, to be filed square. Centering 2 in. from this, drill the crank-pin hole. File a square end on the axle for riveting to the crank. Use a piece of hinge pin for the crank pin, supplying washers, as in Fig. 13.

Scribe the inner and outer diameters of the wheel with a pivoted stick, as in Fig. 14, and cut the outside with a keyhole saw. Smooth with a spokeshave. Nail, across the two faces, pieces of 1 by 4 in. stock with the nails in the waste wood. Locate the wheel centre by scribing intersecting arcs from various points on the inner rim line. Bore holes in these temporary "spokes" to fit a piece of broomstick snugly; the spokes are nailed to the broomstick and a stout wooden crank is attached, after mounting in 2 by 4 in. bearings held in the vise. Stand on the floor a board long enough to serve as a tool rest, bracing it to the bearings. On each side of the wheel, with the least possible clearance, nail a guide piece, preventing side wobble with relation to the tool rest. If another person turns the crank, the belt groove detailed in Fig. 1 can easily be turned.

Turn the spokes and hub, bore 1/4 in. holes, 1/2 in. deep, in the large ends of the turned spokes, and locate the holes in the hub by stepping around the circumference with a pair of dividers spanning the radius of the hub. When the inside of the rim is cut and smoothed, bore 1/4 in. dowel holes through it at the proper points for the spokes. All being ready, glue up, inserting the spokes in the hub and inside the rim, driving the dowels from the outside.

The illustration below Fig. 6 shows a method of holding the wheel true until dry. Insert a 3/8 in. rod into the hub and clamp it level in the vise. Tack a board across the bench end, shimming it square with the rod, and place the wheel. If the spokes are tightly fitted, the hub will bulge outward. Force it into position and hold with sticks clamped to the axle. Rotate it until the part of the rim inclined outward is at the top, where it can be tied with a string, its position being proved by a square held along the shaft.

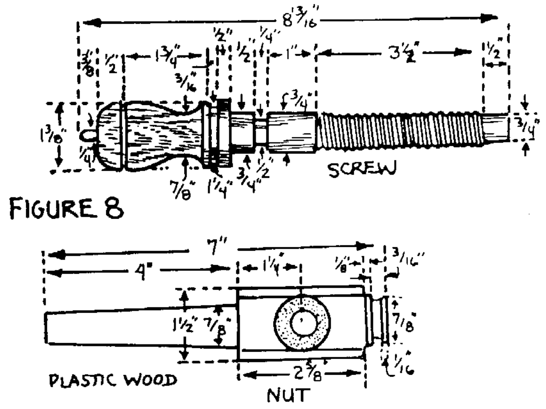
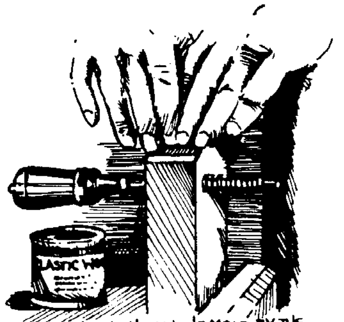
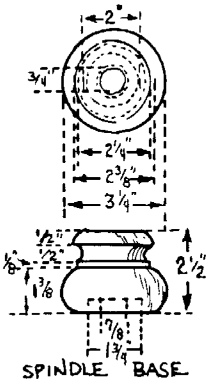


FIGURE 8



FORMING THE NUT IN THE MOLD BY THE USE OF PLASTIC WOOD



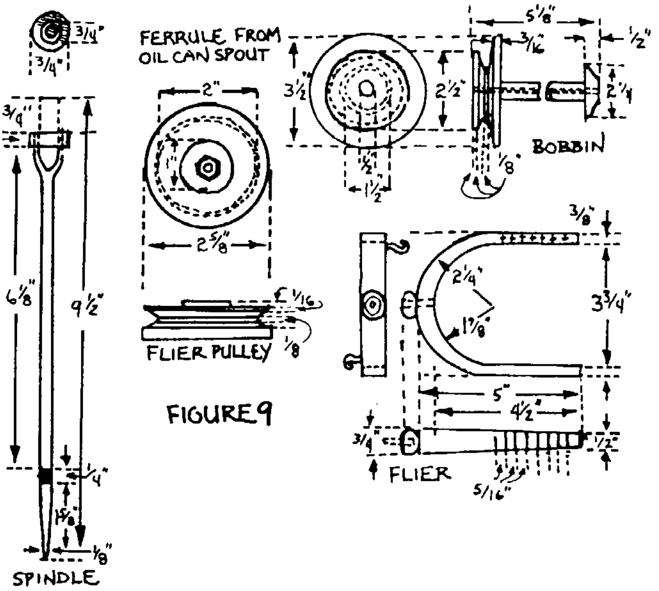


FIGURE 9

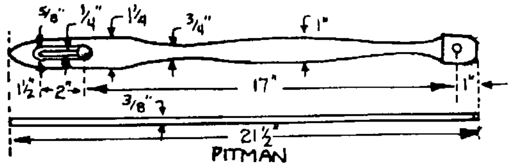
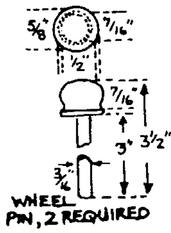


FIGURE 10

Figure 12 dimensions the oak base. Cut the stock 18 in. long, and work from a centre line. To make the molding, **rabbet** the top edge 1/8 by 3/8 in. Round the corners to a radius of 1/2 in. Plane off the bead corner and work it round. Bore 1½ in. holes for the ends of the guide, and

FIGURE 11



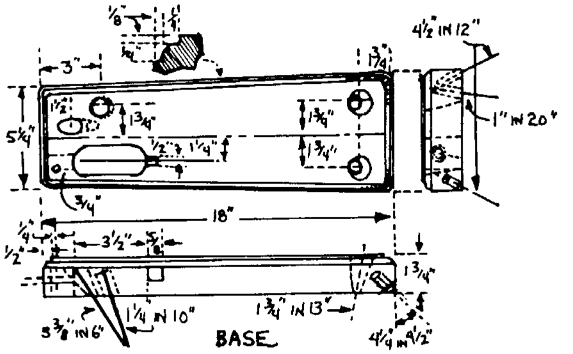
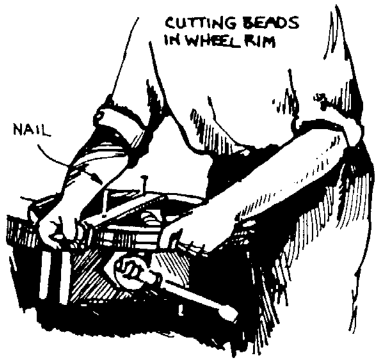
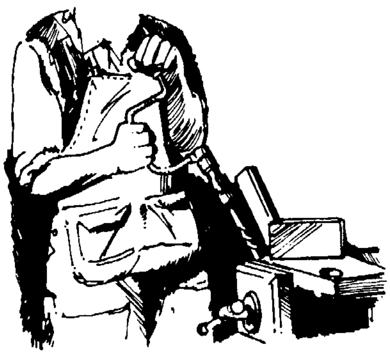


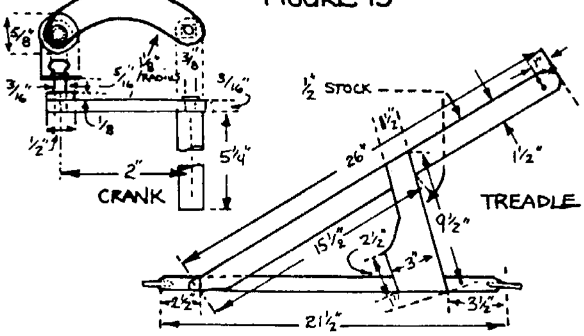
FIGURE 12


CUTTING BEADS IN WHEEL RIM
NAIL



BORING HOLES FOR LEGS

FIGURE 13



SCRIBING THE RIM OF WHEEL PREPARATORY TO SAWING

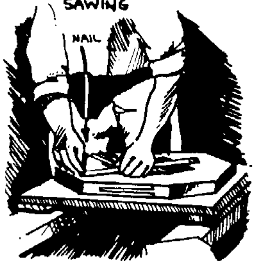


FIGURE 14

saw out the material between. The screw bearing is 3/4 in. in diameter, 1 in. from the bottom and centred on the nut guide. A 3/4 in. hole, 5/8 in. deep, receives the end of the screw. Make a 1/4 in. square key hole 1/2 in. from the end and 1/4 in. from the screw centre. The nut is slipped into the slot in the base and the screw turned into the nut until the 3/4 in. nose on its end is fully seated in the corresponding hole in the bottom of the slot. Then a 1/4 in. key is inserted in the key hole above referred to, and driven in until it passes across the ¼ in. groove in the screw, locking the latter in place, and enabling the nut to be traversed back and forth by turning the screw. The spindle base fits on the taper portion of the nut, and the spindle crossarm on the upper part of the nut taper, above the spindle base. Next, the spindle supports are driven into the crossarm, and the spindle fitted into its leather bearings between them. Block the base in the vise at an angle of 3-3/8 in. rise in 6 in., and, holding the bit vertical, bore the distaff-support hole, centering 1½ in. from the narrow end and 1 in. from the base centre. This hole tapers from 3/4 in. at the top to 5/8 in. at the bottom.

The 5/8 in. hole in the bottom for the long leg is 3 in. from the narrow end and 1¾ in. from the centre leaning toward the wide end 1¾ in. in 10 in., and toward the centre 1 in. in 20 in. The angles of the front legs can be accurately bored by the use of a guide, as indicated in the illustration beside Fig. 13. They incline outward from the centre 4½ in. in 12 in., and, parallel to the base centre, 4¼ in. in 4½ in.

Assemble the legs with the base, stand on a floor, and scribe the leg ends ¼ in. up for cutting.

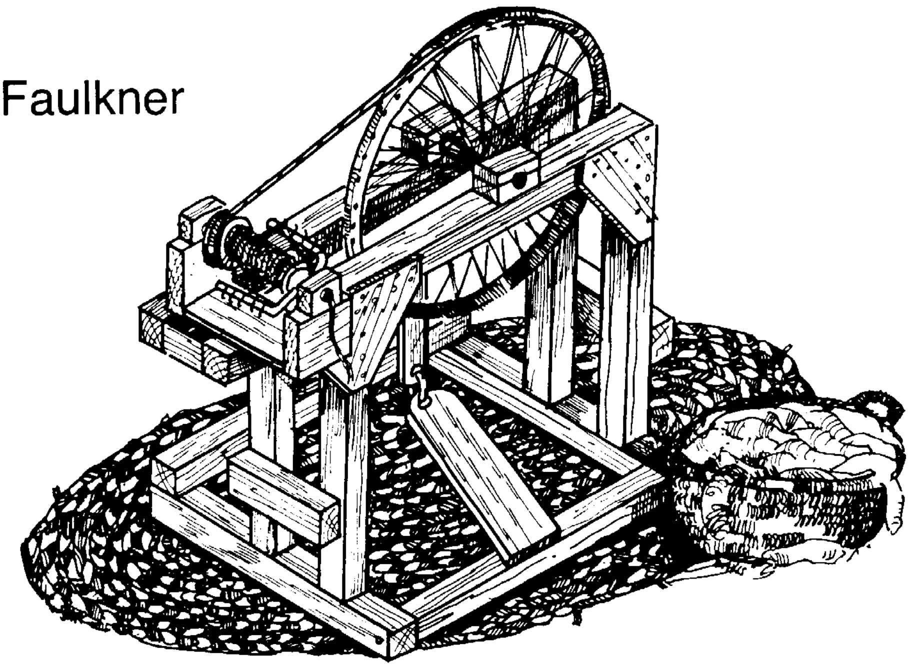
Dress the wheel to thickness. Scratch the bead V's with a nail point in a pivoted stick. Clamp the axle in a vise, push the wheel against the bench end, and, holding a ¼ in. chisel against the bench top with the right hand, turn the bead by rotating the wheel with the left hand, pressing the rim against a stop on the bench end to secure a uniform cut. Sand the wheel, assemble the spindles and put the wheel on its axle. Align the grooves with the spindle and bobbin pulleys so as to mark the axle. Drill a 1/8 in. hole through hub and axle to receive a piece of nail as a key.

The pivoted member of the treadle (Fig. 13) is 1 in. square, with the ends turned to a taper. Use pieces of spikes as pivot pins, and hang 2 in. above the floor. The pitman, Fig. 10, has a ¼-in. slot at its upper end to accommodate the crank-pin body. In order that the head of the crank-pin with its washer rides on the shoulder. Attach the the latter terminates, at its lower end, in a 5/8 in. hole. Centering 2 in. from this, at the other end of the slot, is another 5/8 in. hole; this is drilled only ¼ in. deep. From this hole to the first, another slot is cut, 5/8 in. wide and ¼ in. deep, as indicated by the double lines in Fig. 10. This makes a shouldered slot, ¼ in. wide, on one side of the pitman and 5/8 in. wide on the other. The head of the crank pin with its washer rides on the shoulder. Attach the pitman end to the treadle with a leather thong tied underneath.

Give the wheel a coat of oil, and when dry and sanded off, give a second coat. Splice a single-string belt around the wheel and both pulleys.

The Lesotho Spinning Wheel

by C.J. Howse & M. Faulkner



Anyone wishing to produce a spinning wheel similar to the one described in this article must remember that the most helpful virtue to have is IMAGINATION. Any specific item in the material list that cannot be obtained easily should not be taken as the only thing that will suffice. The material list is a flexible one. If any material listed is not available, use the principle of the design, or modify it to suit those materials that are available.

Tools

The tools necessary for manufacturing the complete spinning wheel are listed below:

- Pedestal drill – or a hand power drill with a drilling stand attachment.
- Drill vise – 2" capacity is sufficient.
- Twist drills – 1/8, 3/16, 1/4, 17/64, 5/16, 21/64, 23/64, 3/8, 1/2, 3/4, 49/64 and 1" dia. drills.
- Circle cutter – consists of a pilot drill with a movable single point cutting tool which can be adjusted to a radius of 2".
- Bench and bench vise.
- Hacksaw.
- Crosscut saw.
- Mitre box and tenon saw to suit – an adjustable type if possible or a solid type that can cut right angles as well as mitres.
- Large flat screwdriver.
- Hammer – 8 oz.
- Steel rule – 12".
- Combination pliers.
- Two 'C' clamps.
- Wood chisel – 1½ inch dovetail.
- Wood glue
- Roll of masking tape.
- Ball of bailing string.
- Oxy-Acetylene welding equipment.
- Afrox M15 bronze and flux – or other type of brazing spelter and flux.

Wheel Frame Parts List

Part	Quan.	Size	Material
A	2	1½ x 2 x 28	Cheap unplaned pine or any other cheap structural wood
B	4	1½ x 2 x 18	
C	2	1½ x 2 x 18	
D	2	1½ x 2 x 6½	
E	1	1½ x 2 x 24	
F	1	1½ x 2 x 20	
G	1	3 x ½ x 14	
H	2	6 x 6	Tempered Masonite ¼" thick (Hardboard)
J	2	7 x 6	
K	1	1½ x 2 x 3½	Cheap unplaned pine or any other cheap structural wood
L	1	1½ x ½ x 21	
M	2	4 - 5" nails	

Panel pins ¾" lg.	60
Woodscrews No. 12 x 3" lg.	20
Nails 1½" lg.	6

Wheel Frame Assembly Instructions

All pieces of pine are cut to length with square ends, using the mitre block.

Part A is then glued and screwed, using No. 12 x 3" woodscrews to part B. One at the end and one 22" further along part A, making sure that the edges are flush. This is repeated for the remaining parts A and B. Before screwing part A to part B, part A should be pre-drilled using a ¼" dia. drill (this is to take the screw shank) and part B should have 1/8" dia. spotted into it from those in part A. This provides easy alignment and screwing.

The gussets, parts H and J, are then cut to shape and glued and nailed onto parts A and B using ¾" panel pins.

Parts D are then attached 4" from the end of parts B, gluing, and nailing the two sides together, using part K as

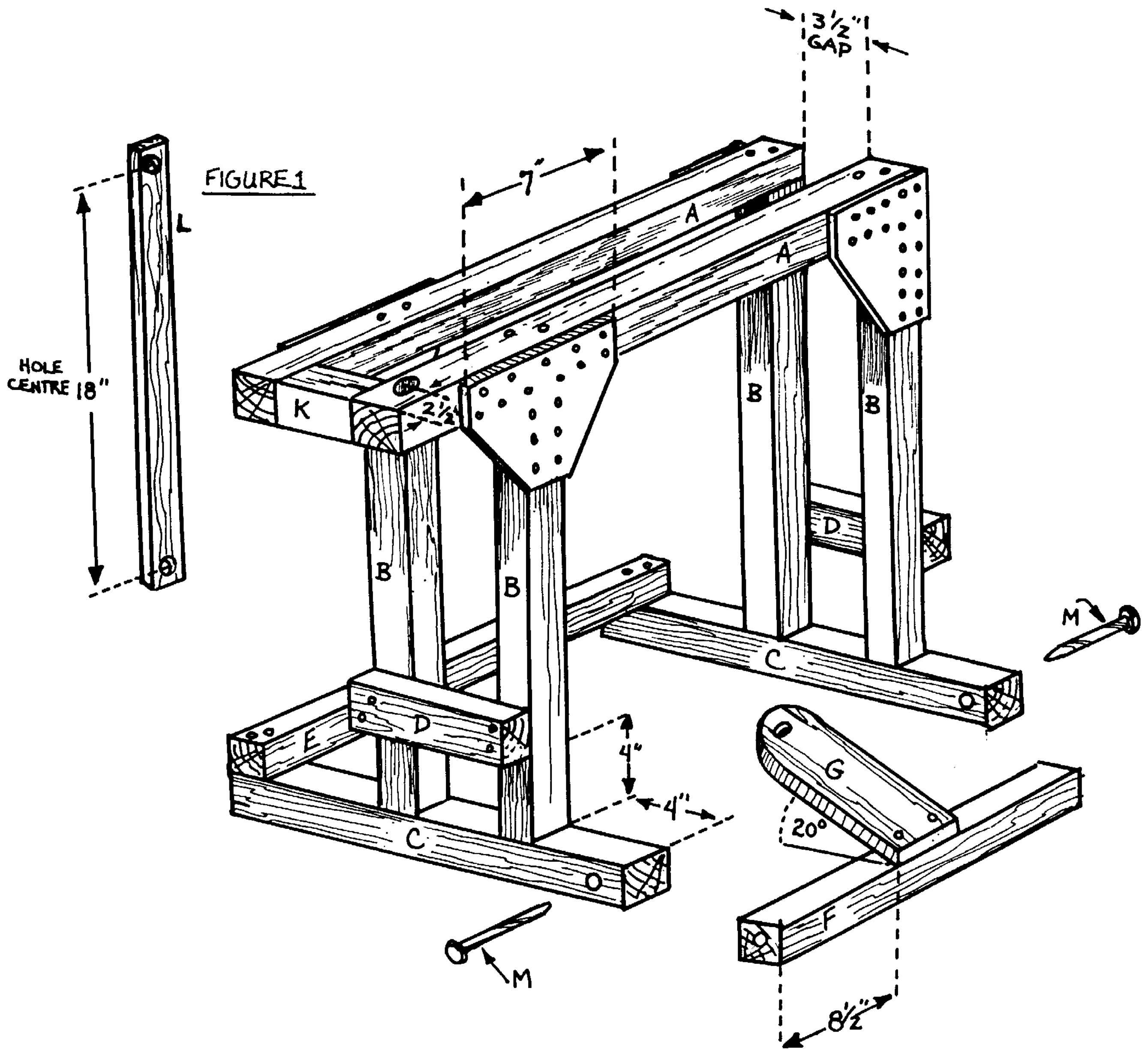


FIGURE 1

a spacer. Part K is also glued and nailed into position.

Parts C are then glued and screwed onto the ends of parts B using No. 12 x 3" woodscrews. This is done 4" from the end of part C and making sure that these parts are parallel. Before screwing, part C should be predrilled ¼" dia. for the screw shank and 1/8" dia. holes spotted through them into parts B.

Part E is then glued and nailed onto parts C at their extreme ends.

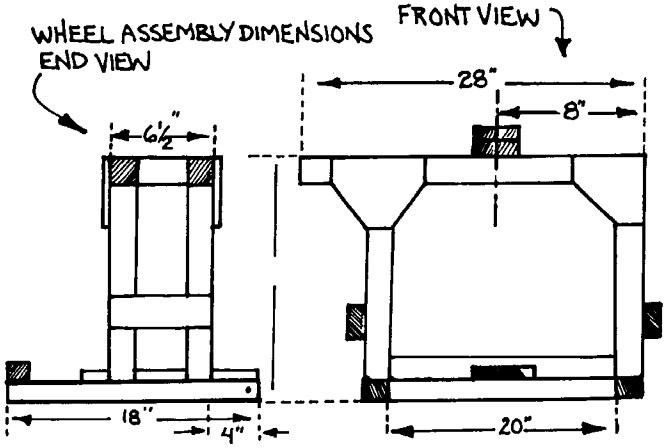
Part G is glued and nailed onto part F at its mid-point and at approx. 70 degrees. This is followed by drilling a ½" dia. hole through part G ¾" from the end, and 1/8" dia. holes centrally in the ends of part F.

Two holes clearance dia. to suit the 4" nails, are drilled into the sides of parts C 3/4" from the end and 1" from the bottom edge.

Part F is positioned between parts C and 4" nails are driven home (parts M in the assembly illustration).

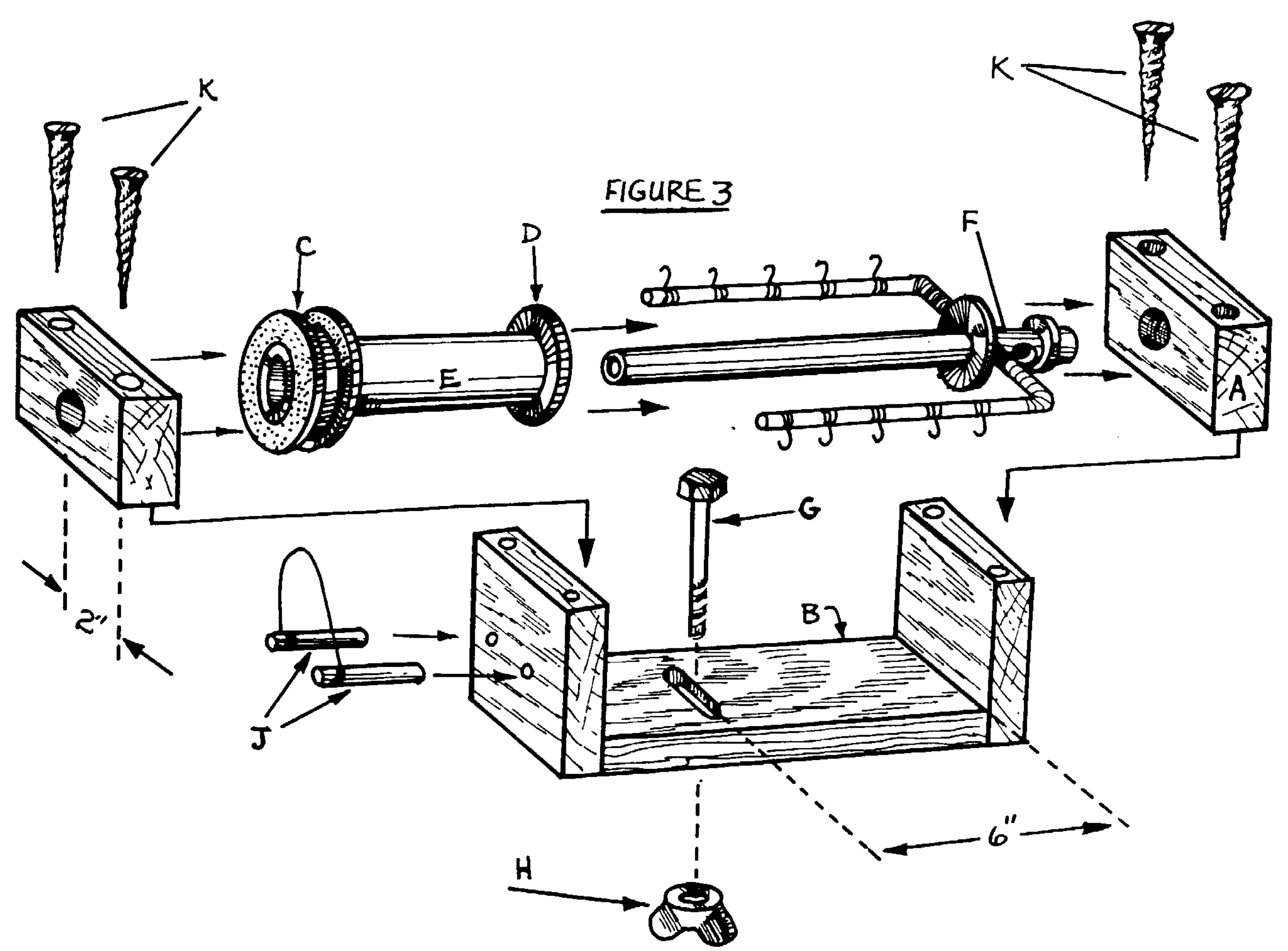
Part L, the link between the foot pedal and the wheel crank, is then drilled for two ½" dia. holes. One 1½" from the end and the other 18" further along (these sizes may have to be adjusted, so this stage should wait until final assembly of the spinning wheel).

FIGURE 2



WHEEL ASSEMBLY DIMENSIONS END VIEW
WHEEL BEARING CENTRES FRONT VIEW
6½"
18"
4"
28"
8"
20"

FIGURE 3



Cradle Assembly Parts List

Part	Quan.	Size	Material
A		1 x 2 x 3½	Meranti or some other hardwood
B		¾ x 4 x 9	Cheap unplaned pine or any other cheap structural wood
"		¾ x 4 x 3½	
C		3"dia. disc 1"hole	
"		3½"dia. disc 1"hole	Tempered masonite ¼" thick (hardboard)
D		3½"dia. disc. 1"hole	
E		1" o.d. x 7½"	Aluminium or plastic tubing
F		¾" o.d. x 12"	Thin wall steel tubing (chrome plated curtain rod)
"	1	¼"dia. x 18"appx.	Concrete reinforcing rod
"	1	¾" i.d. x 1/16" thick	Mild steel washer
"	1	14S.W.G. x 40"appx.	Fencing wire
"	1	2½" dia. disc ¾" hole	Tempered masonite ¼" thick (Hardboard)
G	1	5/16"dia. x 3½"	These can be fabricated using the bicycle wheel spindle and nuts.
H	1	Wing nut to suit bolt	
J	2	3/8"dia. x 1½"	Wooden dowel rod
K	4	No. 12 woodscrews 2½" lg.	

Cradle Assembly Instructions

Part F. The ¾" o.d. tube is cut to length and then two holes are drilled through the tube. These holes must be on centre. One hole is 3/8" dia. and 1-3/8" from the end of the tube, the other is 17/64" dia. and is 2" from the same end of the tube.

The ¼" dia. reinforcing rod is cut to length, and bent at right-angles 8" from one end. The longer end is then threaded through the 17/64" dia. hole, in the ¾" tube, and then bent again to form a 'U' shape. This second bend, which is on the other side of the tube, is 4" from the first one. The finished operation leaves the tube loose in the centre of the 'U' shaped reinforcing rod.

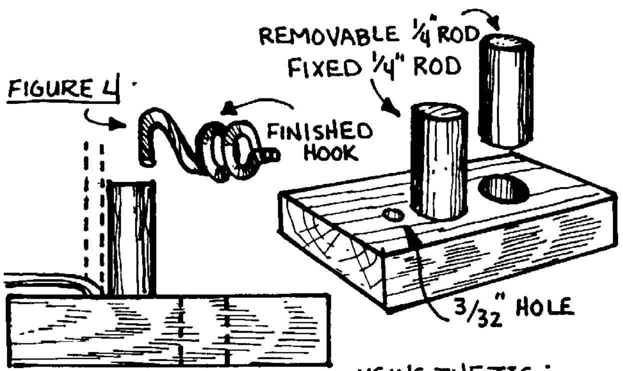
Position the reinforcing rod equally each side of the tube, and with the arms of the reinforcing rod in line with the tube. The rod is then brazed in this position. After brazing the rod arms are trimmed to equal lengths. This stage is important as the centralising of the rod and the arm lengths affect the balance of the finished flyer (part F).

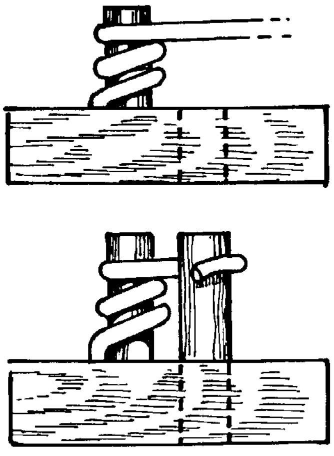
The ¾" i.d. washer is pushed on to the ¾" tube, the same end as the holes, until it is 1" from the end. The washer is then brazed in this position.

The 14 gauge fencing wire is cut to approximate length and then formed into the wire hooks shown below in Fig. 4. This can be done free-hand or by using the simple jig shown in Fig. 5. After the wire hooks have been manufactured, six are pushed on to each arm of the flyer (part F). These are spaced equally along the length of the arms and taped in position. Masking tape, Sello-tape or insulation tape can be used for this purpose.

A disc 2¼" dia. is cut from the sheet of ¼" thick masonite using the circle cutter. The disc is then drilled through its centre with a ¾" dia. drill, and pushed on to the ¾" tube (opposite end to the holes and washer) right up until it touches the reinforcing rod.

FIGURE 4





USING THE JIG:

1) INSERT THE WIRE INTO THE 3/32" HOLE AND BEND AT RIGHT ANGLES.

2) WIND THE WIRE AROUND THE FIXED ROD TWO COMPLETE TURNS

3) INSERT THE REMOVABLE ROD AND WIND THE WIRE BACK AROUND IT TO FORM THE HOOK. THEN CUT OFF WITH PLIERS.

FIGURE 5

Part E is then cut from the 1" o.d. aluminium tube, making sure that the ends are cut square.

Three discs 3½" o.d. (parts C and D) and one disc 3" o.d. are cut from the masonite, again using the circle cutter. All four discs are then drilled through their centres using a 1" dia. drill. Take two 3¾" dia. discs and smear glue onto one face of each, then smear glue onto both sides of the 3" dia. disc. The discs are then sandwiched together with the 3" disc in the centre of the two 3¾" discs. Insert part E into the 1" dia. holes in the discs to keep them central and clamp the sandwich together until the glue is dry. Push the remaining disc on to the other end of part E. This assembly is the completed bobbin.

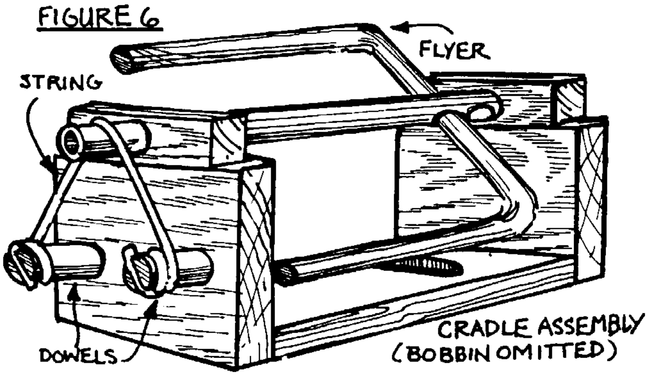
Cut the pieces of pine for part B. Glue and nail the 3½" pieces to the ends of the 9" piece, making sure they are flush at the edges. The heights of the 3½" pieces above the 9" piece have to be the same or this will have an adverse affect on the bearings of the flyer.

Parts A are then cut from meranti (or some other hardwoods) and a 49/64" dia. hole is drilled 2" from the end and 1" in from the edge. This hole should be drilled through both blocks when they are clamped together (with their ends and edges flush) so that a matched pair is obtained. If there is any difference in the height of the holes this also has an adverse affect on the flyer bearings. Two holes are drilled in each block, ½" from both ends and midway on the 1" edge. Finally these holes are counterbored on the blocks' top face to suite the 2½" long woodscrews. Both blocks are then soaked in oil.

The bobbin (parts C, D & E) is slipped onto the flyer (part F), as shown on the exploded view. The two bearing blocks (part A) are then slipped on to the ends of the flyer. Place the bearing blocks onto the ends of the cradle (part B). Make sure that the flyer and bobbin both turn easily in the bearing blocks, and that the flyer is parallel to the cradle. After the blocks have been positioned the screw holes are spotted into the cradle using a 1/8" dia. drill. This gives the woodscrews a good location and eases effort required to screw them in. Just before the bearing blocks are screwed into position there are two final operations that have to be carried out on the cradle. One of these has to be done when the bicycle wheel has been positioned (this is described in the final assembly) so will have to wait, but the other can be carried out now. With the bobbin, flyer and bearing blocks in place on the cradle position two 23/64" dia. holes 1½" down from the cradle top and approximately 2½" apart. These holes are equally spaced either side of the ¾" tube as it protrudes through the rear bearing block. Two 3/8" dia. wooden dowels are then wedged into these holes, and a piece of string is attached from one dowel to the other.

This string acts as a drag or brake on the flyer, so giving the differential speeds of flyer and bobbin. This difference in speed is necessary to enable the yarn to be wound onto the bobbin, and by twisting the dowels, so loosening or tightening the string, the pull on the yarn can be adjusted (Fig. 6).

FIGURE 6



Wheel and Bearing Assembly Parts List

Part	Quan.	Size
A	1	Bicycle front wheel complete with spindle and wheel nuts – Approx. 26" dia. x 1-3/8" wide.
B	1	5/16" dia. Bright drawn mild steel x 12" approx.
C	2	Cone nuts from the wheel spindle
D	4	1½ x 1½ x 3½ Meranti or other hard wood
E	4	No. 12 woodscrew 2½" lg.

Wheel and Bearing Assembly Instructions

Bend the 5/16" dia. bright drawn mild steel to the shape shown in Fig. 8. This is the wheel crank, part B, and the curve on the crank arm is essential so that a smooth action is obtained on the wheel.

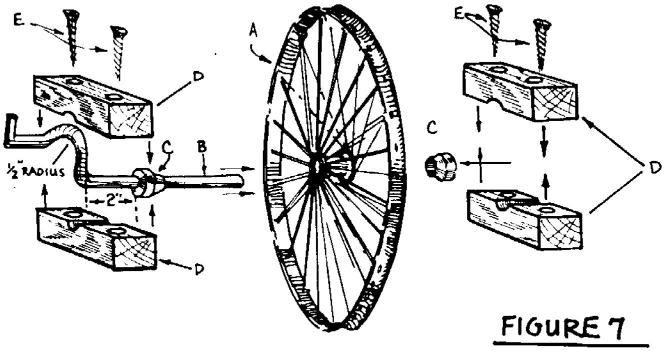


FIGURE 7

Remove the spindle, cone nuts, standard nuts and the ball bearings from the bicycle front wheel. The ball bearings can be put to one side as they will no longer be required.

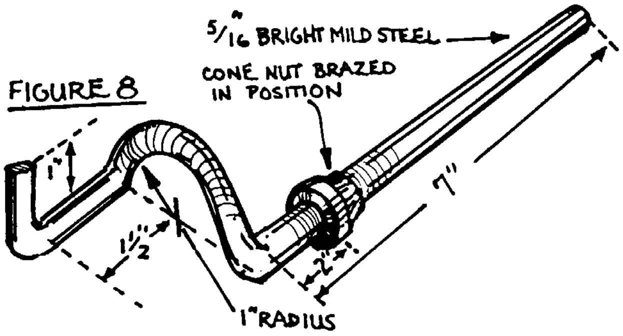
Heat up the cone nuts (part C) with the Oxy-Acetylene equipment until they are cherry red, then bury them in sand and allow them to cool down. This will soften the steel so that they can be drilled. Next run a 5/16" dia. drill through the existing tapped hole in both cone nuts.

Push one cone nut on to the crank as shown in Fig. 3, so that the cone shape faces the end of the crank it was pushed onto. There should be a space of 2" between the curved arm of the crank and the square face of the cone nut. When this gap is correct, the cone nut is brazed into position.

The crank, with the cone nut brazed onto it, is then inserted through the wheel hub and the other cone nut pushed onto the crank. The second cone nut should have its cone end pointing towards the wheel. Press the second cone nut up against the wheel, clamp and braze. The wheel must be held tightly between the cone nuts, otherwise the wheel will not be centralised correctly and will run out of true. When the second cone nut has been brazed, the wheel is then brazed to the cone nuts.

The wheel bearings, parts D, are put into pairs and clamped together so that both their edges and ends are flush. A 5/16" dia. hole is then drilled through the blocks, so that half a hole is produced in each, 1¾" from their ends (see Fig. 7). While they are still clamped together, drill the two screw holes through both blocks using a ¼" drill. One part D in each pair has these holes countersunk on the top surface to suit the 2½" woodscrews. Both pairs are then soaked in oil. These parts must be kept together as they are manufactured, as they are matched pairs and are used as such. If they are piled in one heap it will take time and energy to sort them before use.

FIGURE 8



Final Assembly Instructions

The wheel bearings (part D wheel assembly diagram) are placed over the wheel shaft in their matching pairs.

The wheel and bearings are then placed on the frame with the wheel crank to the rear. The shaft is positioned 8" from the end of the frame (see Fig. 9) and screwed into position. The wheel should be parallel with the sides of the frame.

Place the cradle assembly on the frame as shown in Fig. 9, and position it until the pulley on the bobbin is in line with the bicycle wheel. When this position is obtained drill a 5/16" hole through the cradle base and frame. This hole should be drilled so that it passes through the centre of the frame side about 2½" from the end (see Fig. 1).

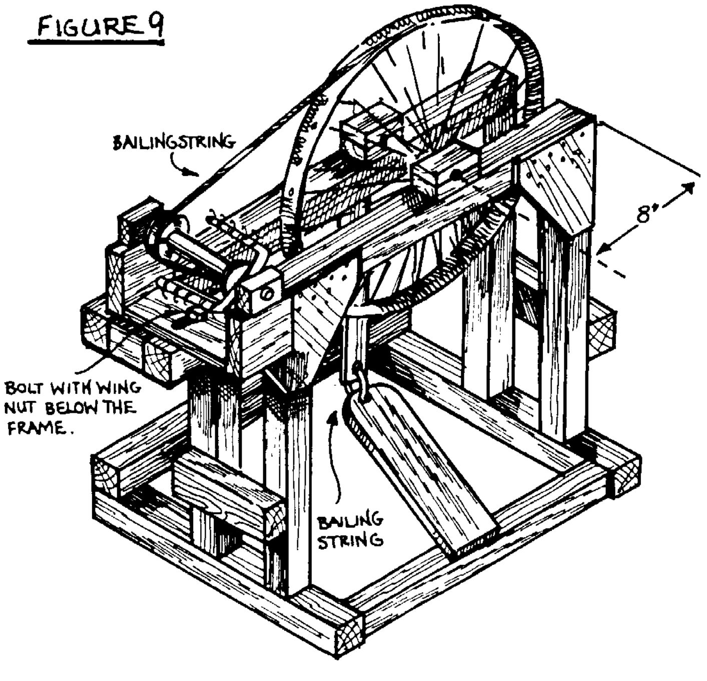
Take the cradle off the frame, and using a wood chisel elongate the hole in the cradle base, at right angles to the sides, for a length of 2½". The elongated hole provides adjustment on the cradle and should be 5/16" wide for its complete length, so that adequate clamping can be obtained from the bolt.

Using the 5/16" dia. bolt and wing nut (parts G and H of Fig. 3) secure the crade to the frame. The bolt is pushed through the cradle first and the wing nut is underneath the frame.

Adjust the hole centres on part L (Fig. 1) so that the pedal is clear of the ground when the wheel crank is at its lowest position. Slip one hole over the end of the crank and secure the other to the pedal with string. The string passes through the holes in the respective parts but is slack after knotting so that it provides a flexible joint.

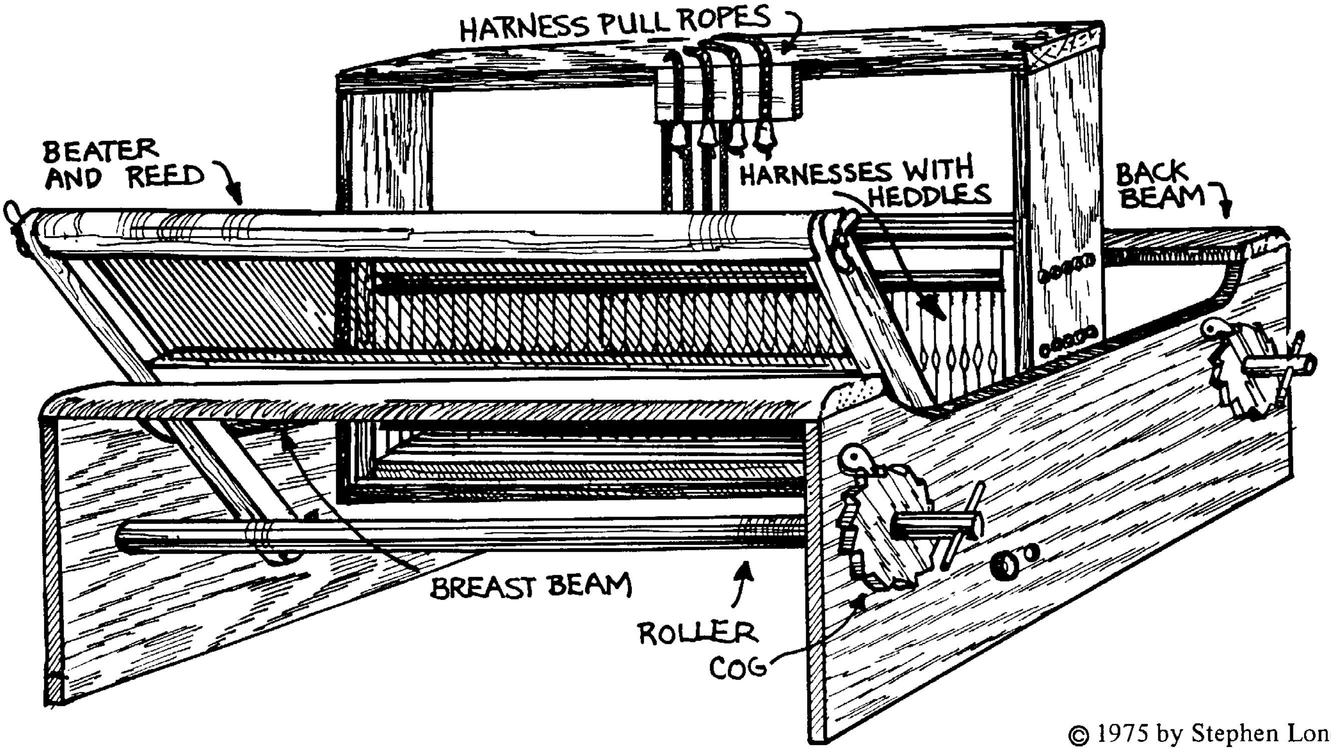
Finally, string is threaded round the bicycle wheel, then the bobbin pulley, tied securely, and the surplus cut off. Any slack in the string can be taken up by moving the cradle.

FIGURE 9



A Hand Built Table Loom

by Stephen Lones



© 1975 by Stephen Lones

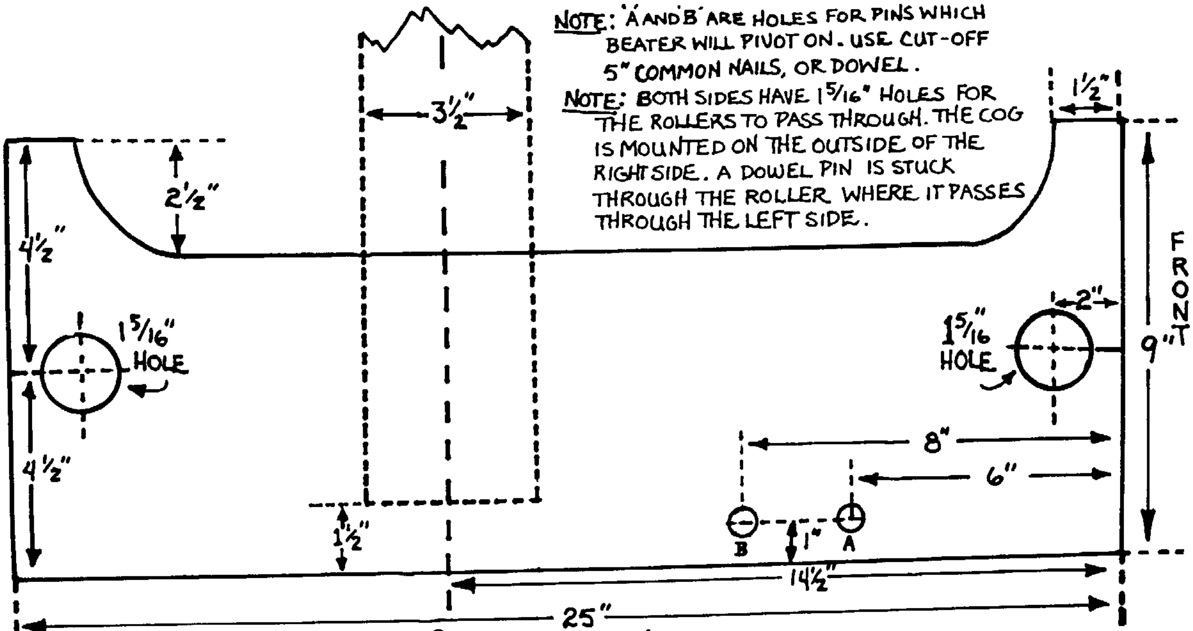
Loom weaving involves the intertwining of fibres, both natural and synthetic, usually at right angles to one another. Synthetic fibres are usually purchased commercially spun, while natural fibres (such as wool, linen, cotton, mohair) can be purchased in the raw state and spun by the weaver. Spinning varies greatly depending on thickness, eveness, type of fibre and spinning equipment. Some weavers use handspun in conjunction with commercially spun yarns (either natural or synthetic), and others have a preference for one or the other.

In the same manner there is great variation in weaving styles. Pattern weaving is a focus for many, while colour and texture combinations hold interest for others. Hangings, tapestry, rugs, clothing and personal or practical articles may be woven. The number of threads per inch can vary from four to forty.

A table loom must accommodate a wide range of individual preference and style. It must be rugged enough to withstand heavy string rug warps and sensitive enough to weave something as fine and delicate as a bedsheet. Care put into the design and construction of a loom is well worth it. The weaver feels the difference and the finished product reflects it. If a loom is solidly built from hardwood, it will last a lifetime.

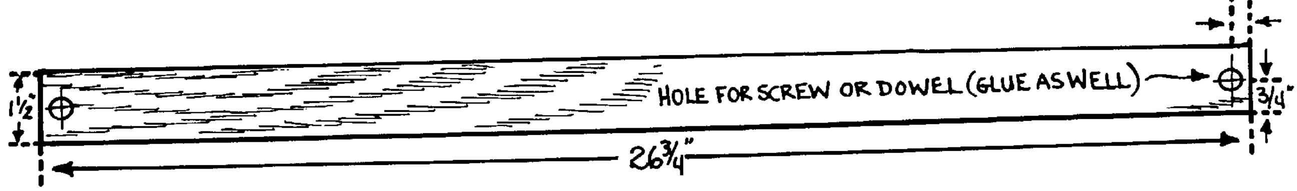
In loom weaving the **warp** threads, running front to back on the loom, are put on first. These threads are wound onto the rear roller (the **warp beam**) and brought forward to have the **weft** threads woven at right angles into them. As the cloth is produced it is wound forward and stored on the front roller (cloth beam). The rollers have cogs and ratchets which control the tension on the warp threads and allow the rollers to move freely one direction, but not the other.

Between the front and back rollers the warp threads pass through two parts of the loom. Starting from the warp beam each thread first encounters a **heddle**, a thin wire, string or piece of flat steel with an opening in the middle called the **eye** which the warp thread passes through. The heddle is held vertically in a frame called a **harness**. Looms have anywhere from two to twelve harnesses, four being a common amount. A typical way of threading the warp on a four harness loom would be to string the number one warp thread on the right side of the loom through the first heddle in harness one. The second warp thread is strung through the first heddle in frame two. Number three thread goes through number three harness and four goes through four. The fifth thread then starts with the first harness again, going through its second heddle; and so on until


NOTE: 'A AND B' ARE HOLES FOR PINS WHICH BEATER WILL PIVOT ON. USE CUT-OFF 5" COMMON NAILS, OR DOWEL.
NOTE: BOTH SIDES HAVE 1 5/16" HOLES FOR THE ROLLERS TO PASS THROUGH. THE COG IS MOUNTED ON THE OUTSIDE OF THE RIGHT SIDE. A DOWEL PIN IS STUCK THROUGH THE ROLLER WHERE IT PASSES THROUGH THE LEFT SIDE.
3½"
2½"
4½"
1 5/16" HOLE
4½"
1½"
1½"
2"
1 5/16 HOLE
FRONT
9"
8"
6"
B
1"
A
14½"
25"

SIDE OF LOOM

BREAST AND BACK BEAMS - TOP VIEW



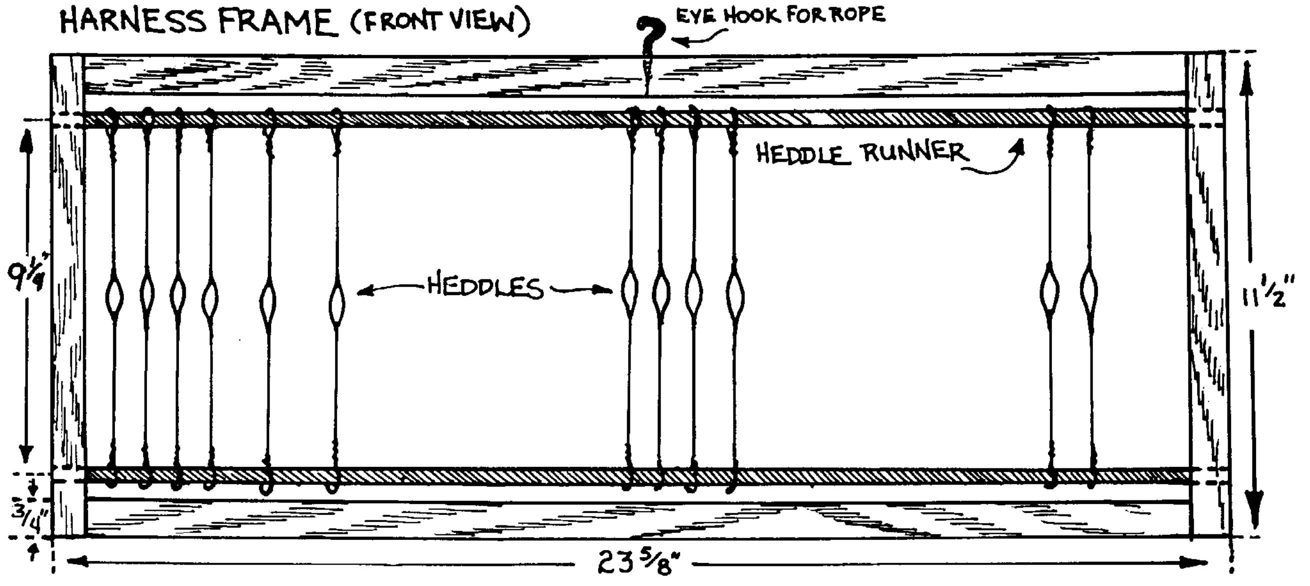
the warp is entirely strung up. Threading the loom is tedious, but the actual weaving makes up for it.

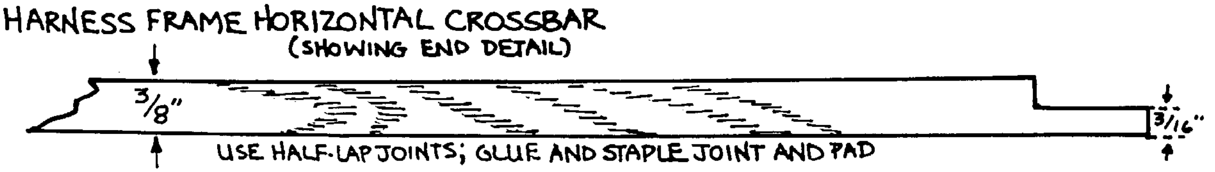
When any harness is raised, it lifts up all the threads passing through its heddles; i.e. every fourth thread. In simple weave (called **tabby**) one half the threads are raised at a time. Harnesses one and three are raised and the weft thread is thrown through the resulting opening (called the **shed**). These harnesses are lowered, harnesses two and four are raised, and the weft is passed back the other direction. Such weaving could be done on a two harness loom also, as long as every other thread is to be raised. Pattern weaving involves using different combinations of harnesses, one, two or three at a time, and different methods of stringing warp threads through the heddles.

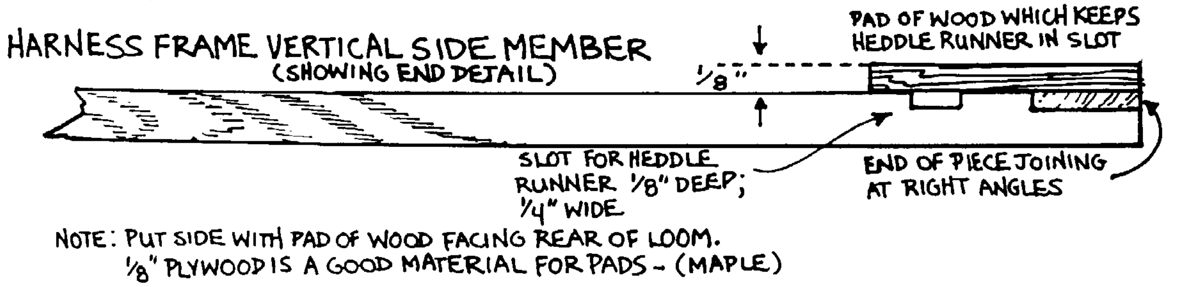
The threads also pass through the **reed**, which is held in a frame called the **beater**. The reed spaces the warp threads apart from one another. Usually one thread passes through each opening in the reed, and the number of openings per inch (the **dent** of the reed) determines the threads per inch of the cloth. The beater also pivots, allowing the reed to be swung through the warp until it packs the last weft thread woven against the cloth previously woven. The amount of force used in swinging the beater determines the **beat** or pack of the cloth. The beater must be strongly made for packing heavy things like rag rugs. It is necessary that the reed can be easily replaced with one of a different dent. When the beater swings the reed should strike the cloth in a vertical position. There should be two sets of pins for the beater to pivot on so it will maintain a vertical position when striking the cloth near the harnesses as well as near the **breast beam**. That way, the cloth can be woven a longer distance before it needs to be wound forward onto the cloth beam.

Most table looms have a box within which the harnesses slide within slots cut into the uprights of the box. A problem arises when the harnesses need to be removed quickly so heddles can be added on or taken off. I use two sets of guide pins in each upright which can be pushed back to allow the harnesses to be removed. The system used ultimately depends on the preference and ingenuity of the builder. Somehow the harnesses must be guided so they don't strike each other.

In North America wire heddles are commonly used on table looms. String heddles could also be used but would require a different set-up and loom design. Wire heddles (and reeds) can be obtained through any dealer of Leclerc




HARNESS FRAME HORIZONTAL CROSSBAR
(SHOWING END DETAIL)
⅜"
3/16"
USE HALF-LAP JOINTS; GLUE AND STAPLE JOINT AND PAD


PAD OF WOOD WHICH KEEPS HEDDLE RUNNER IN SLOT
HARNESS FRAME VERTICAL SIDE MEMBER
(SHOWING END DETAIL)
⅛"
SLOT FOR HEDDLE RUNNER ⅛" DEEP; ¼" WIDE
END OF PIECE JOINING AT RIGHT ANGLES
NOTE: PUT SIDE WITH PAD OF WOOD FACING REAR OF LOOM.
⅛" PLYWOOD IS A GOOD MATERIAL FOR PADS - (MAPLE)

Looms of Quebec.* Heddles must be able to move sideways within the harness frame so they can line up with the openings of the reed. Bars called **heddle runners** allow sideways motion. These bars are mounted within the frame in such a way that they can be easily removed to add on or take off heddles.

Loom Basics

Most table looms are **jack** type. This means the harnesses are controlled individually and are raised to produce a shed opening. It would also be possible to use a **counterbalance** tieup where harnesses one and two are connected by rope to each other via a pulley, and the same with harnesses three and four. Then the two sets of harnesses are connected by rope via another pulley or over a bar. If harnesses one and three are pulled down, harnesses two and four would be raised. Jack type seems most practical for table looms.

One problem is how to raise and lower several harnesses at once while only using one hand and one motion. This operation is performed after each throw of the weft thread and must not become tiring. A common method is to run a rope from the top middle of each harness through a hole in the top of the box and have it catch in a slotted piece of wood mounted top front on the box. Pulling each rope and catching it in a slot can become tedious, but at least such a system is easy to build and can be improved upon later. Leclerc's 22" table loom uses automatic metal changes which work with one motion of one hand. Unfortunately they work hard and produce enough noise to give a headache. Some Swedish looms employ a method which solves all these problems. Each rope coming through the top of the box is connected to a handle which pivots in a semi-circle around a pin. When the harness is raised the handle is in such a position that the rope can gain no leverage to pull the handle around its pivot point. Try to find a loom using this system and study it. The concept is difficult to explain.

A 2½" shed opening is wide enough to take the **shuttle** (a flat piece of wood with the weft thread wrapped around it). A bigger shed would create too much tension on the warp threads. The threads tend to remain on the **warp line** (a straight line drawn between the tops of the **back** beam

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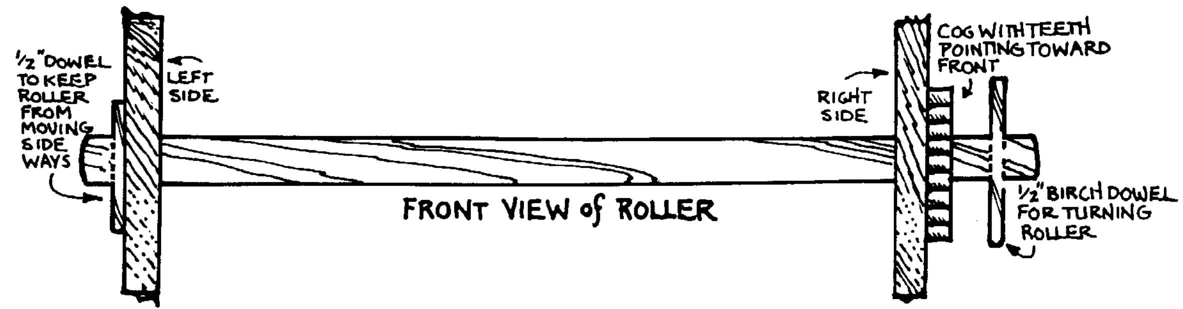
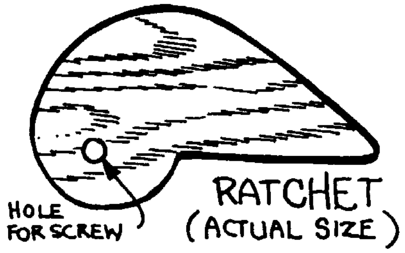
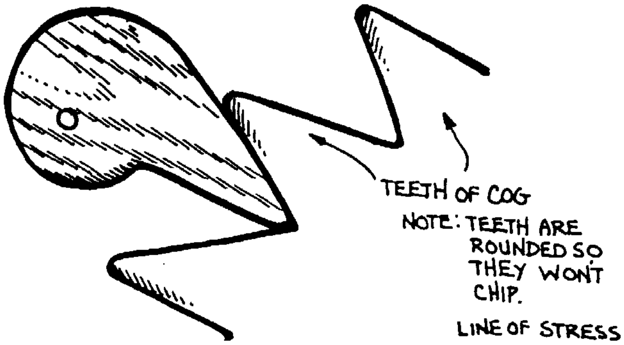
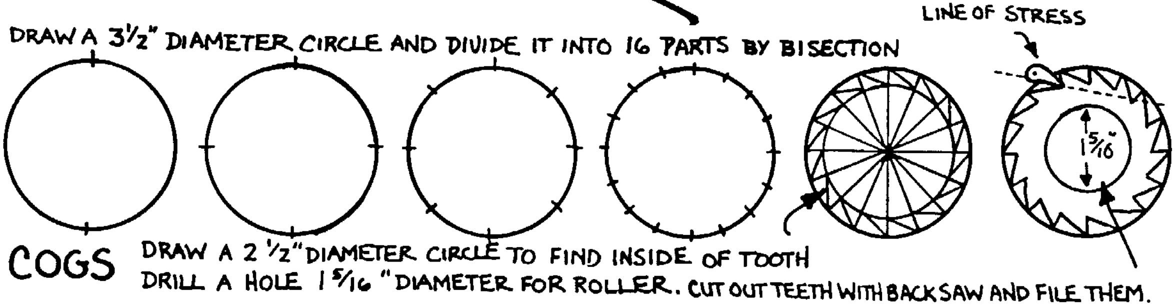
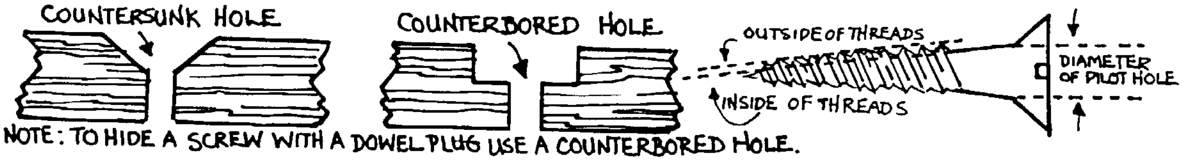
* If there is no authorized dealer near by, you may write direct to: Leclerc Looms, L'Isetville, Quebec, Canada


½" DOWEL TO KEEP ROLLER FROM MOVING SIDE WAYS
LEFT SIDE
FRONT VIEW of ROLLER
RIGHT SIDE
COG WITH TEETH POINTING TOWARD FRONT
½" BIRCH DOWEL FOR TURNING ROLLER






LINE OF STRESS
DRAW A 3½" DIAMETER CIRCLE AND DIVIDE IT INTO 16 PARTS BY BISECTION
1 5/16"
COGS
DRAW A 2½" DIAMETER CIRCLE TO FIND INSIDE OF TOOTH
DRILL A HOLE 1 5/16" DIAMETER FOR ROLLER. CUT OUT TEETH WITH BACKSAW AND FILE THEM.



and the breast beam). When the threads are pulled away from this line, their tension increases. Since Jack type looms have a **rising shed** (the harnesses only move upwards), the harness frames are kept half the height of the shed below the warp line when they are in the lowered position. Then the harnesses which are raised will be half the shed height above the warp line and the tension in warp threads both raised and lowered will be the same. The weight of the harness (including heddles and heddle runners) should be sufficient to depress the heaviest warp threads to be used down the necessary 1¼". They should not be heavier than this minimum or raising the harnesses will become unnecessarily difficult. I use yellow cedar (3/8" x 3/4") for the frames because the heddle runners (1/8" x 1/4" cold roll steel) are heavy. Just consider your own needs and available materials and experiment with it.

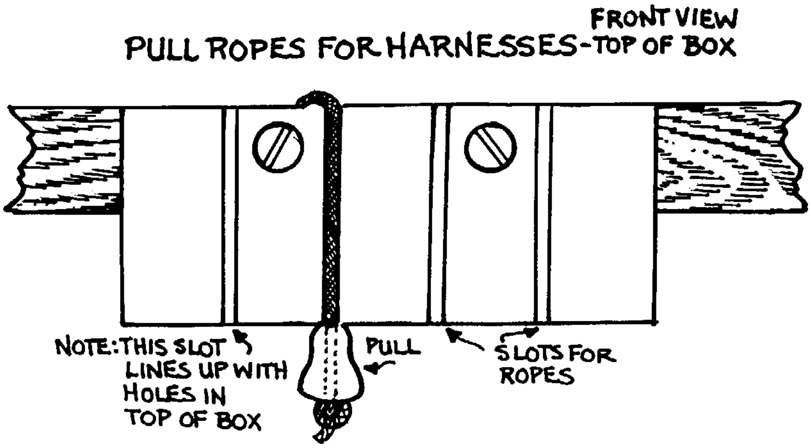
The warp line is also used to position the height of the reed and beater. If the middle of the reed is at the warp line when the beater is in a vertical position then everything is positioned correctly and there should be no need to make the height adjustable. Do remember to have the beater adjust front to back. There should be no side-to-side free play. Use wooden washers if necessary to keep the beater firmly centred between the sides of the loom.

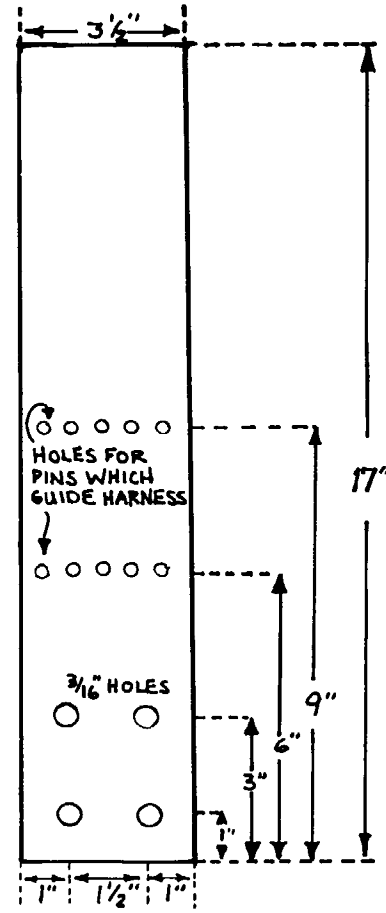
Cogs and ratchets are needed on the cloth and warp beams to adjust tension on the warp. The positioning of the ratchet is very important. If the ratchet just catches the top of the tooth, it may chip or break it. The tip of the ratchet should solidly contact the base of each tooth. Stress must be directed into the body of the cog rather than just into the tooth. The cog must turn freely one direction and the ratchet must engage fully on each tooth when turned the other direction. The cog can be attached to the roller with glue and pins. First bore a 1-5/16" hole in the cog. Then cut out the teeth with a back saw and round all their edges with a file. The cog should fit snugly on the roller. Beware of drilling the hole too small or the cog will break when you tap it on. Maple is a good wood for cogs since it is tight grained. Douglas Fir dowel 1-5/16" diameter makes adequate rollers. Hardwood dowel of that size would be extremely expensive.

Assembly Procedure

Cut all material to length. I use red oak, but you may use whatever is available and suitably strong.

Drill all holes which the head of a screw or bolt will


FRONT VIEW
PULL ROPES FOR HARNESSES - TOP OF BOX



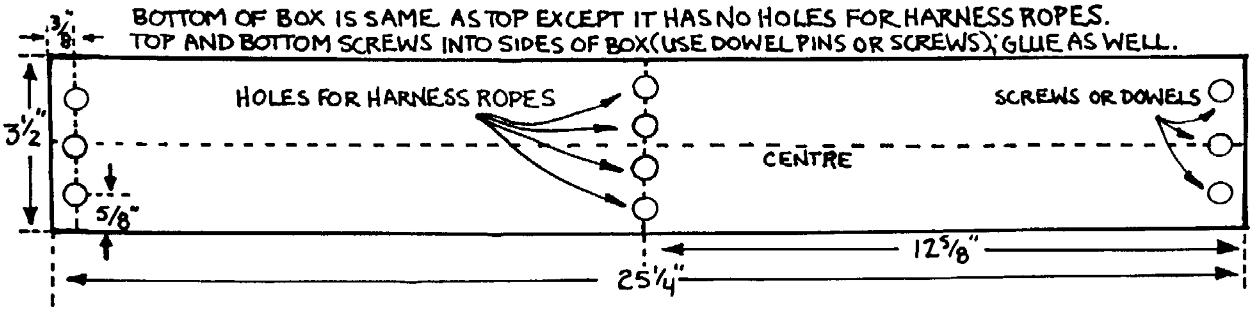
SIDES OF BOX

NOTE: 3/16" HOLES FOR BOLTS ARE COUNTERBORED ON THE INSIDE OF THE BOX WITH A 9/16" HOLE TO TAKE A WASHER AND NUT.

NOTE: HOLES FOR GUIDE PINS - START MEASURE FROM CENTRE. ONE PIN GOES IN THE CENTRE, REMAINING PINS ARE 21/32" APART. USE 15/64" DRILL AND 5" COMMON NAILS CUT OFF TO 1½" IN LENGTH FOR PINS. WORK HOLE WITH DRILL UNTIL PIN SLIDES BACK EASILY. A ¼" IS TOO SLOPPY AND LOOSE.

TOP OF BOX

BOTTOM OF BOX IS SAME AS TOP EXCEPT IT HAS NO HOLES FOR HARNESS ROPES.
TOP AND BOTTOM SCREWS INTO SIDES OF BOX (USE DOWEL PINS OR SCREWS); GLUE AS WELL.

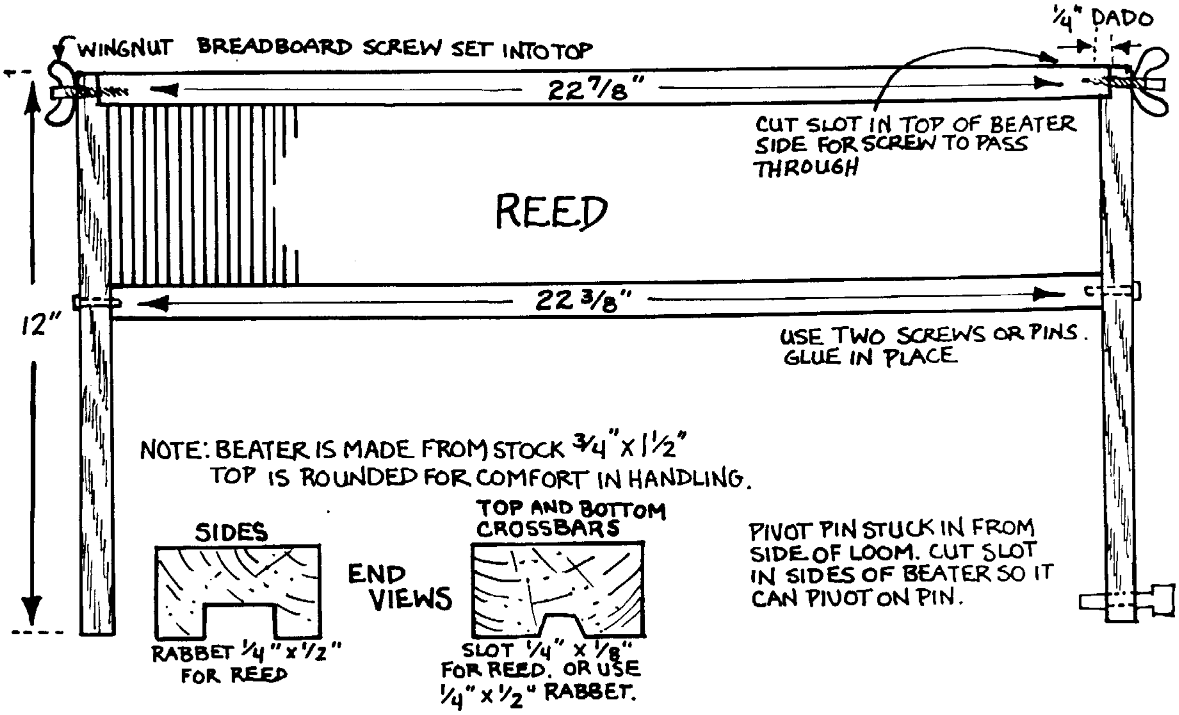


bear against. If you are using a #8 - 1½" countersunk woodscrew, these holes would be drilled 11/64" and then countersunk for the screw head. The bolt holes on the insides of the box uprights need a 9/16" counterbore to accommodate a 3/16" washer and nut flush with the inside surface (use 1½" 3/16" diameter bolts with these to join loom sides to the box). Drill a 1/8" hole first and then counterbore. Then drill the 1/8" hole out to 3/16".

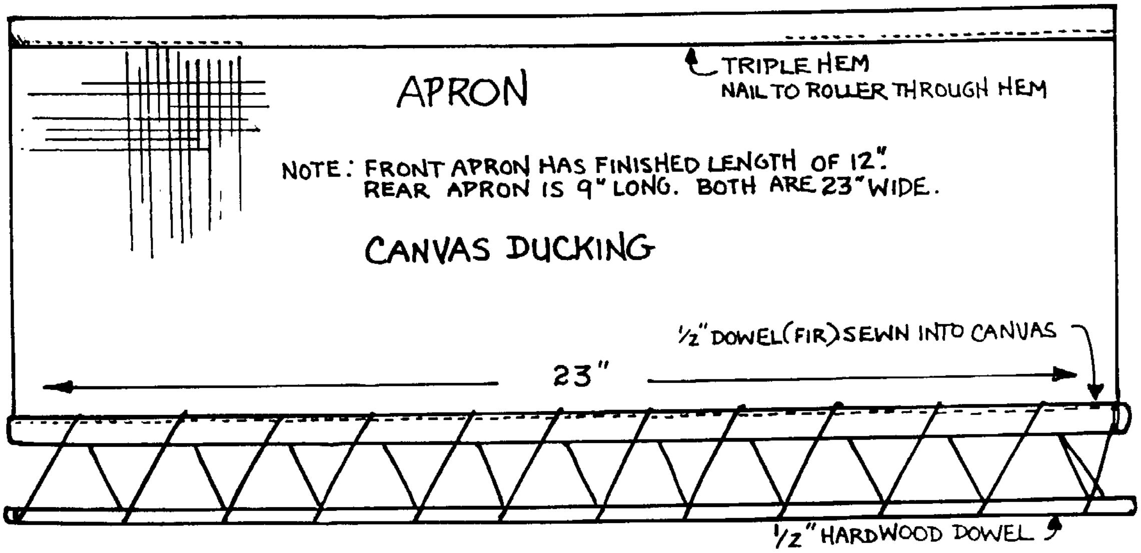
As you assemble the loom, mark for pilot holes in each piece which takes the threaded end of a screw. A good marking technique is to place a predrilled and countersunk piece exactly onto the piece it will join and tap a screw inserted into each hole so the screw tip will mark for the pilot hole. Such a mark also helps guide the drill bit in the same manner as an impression made by a counterpunch. A pilot hole is necessary to prevent the screw from splitting the wood. The hole should equal the inside diameter of the screw threads so they will engage the wood completely. If you plan to use dowel instead of screws then different procedures will be necessary.

Assemble the box for the harness frames first. Lay one of the loom sides down on the workbench with its inside facing up. Place the box on its side on top of this and position and square the two pieces correctly together (middle of box sits 14½" from front of the loom side; bottom of box is up 1½" from bottom of side). Put bolts in the four bolt holes in the box and tap them firmly so they make impressions on the side of the loom. Centrepunch the centre of each impression and drill out to 3/16". Do the other side in the same way. Label parts with a pencil when assembling them so they can be put back together correctly if disassembled. Bolt the sides onto the box with the nuts inside the counterbored holes of the box. Use washers with the bolt head and the nut.

Install the breast and back beams, again using a screw to mark the pilot holes. Push the rollers through the 1-5/16" holes in the loom sides. They should turn freedly but not too loose. The rollers should protrude 1" through the left


WINGNUT
BREADBOARD SCREW SET INTO TOP
¼" DADO
22 7/8"
CUT SLOT IN TOP OF BEATER SIDE FOR SCREW TO PASS THROUGH
REED
22 3/8"
12"
USE TWO SCREWS OR PINS. GLUE IN PLACE.
SIDES
END VIEWS
TOP AND BOTTOM CROSSBARS
RABBET ¼" x ½" FOR REED
SLOT ¼" x ⅛" FOR REED. OR USE ¼" x ½" RABBET.
PIVOT PIN STUCK IN FROM SIDE OF LOOM. CUT SLOT IN SIDES OF BEATER SO IT CAN PIVOT ON PIN.

NOTE: BEATER IS MADE FROM STOCK ¾" x 1½"
TOP IS ROUNDED FOR COMFORT IN HANDLING.



NOTE: FRONT APRON HAS FINISHED LENGTH OF 12".
REAR APRON IS 9" LONG. BOTH ARE 23" WIDE.

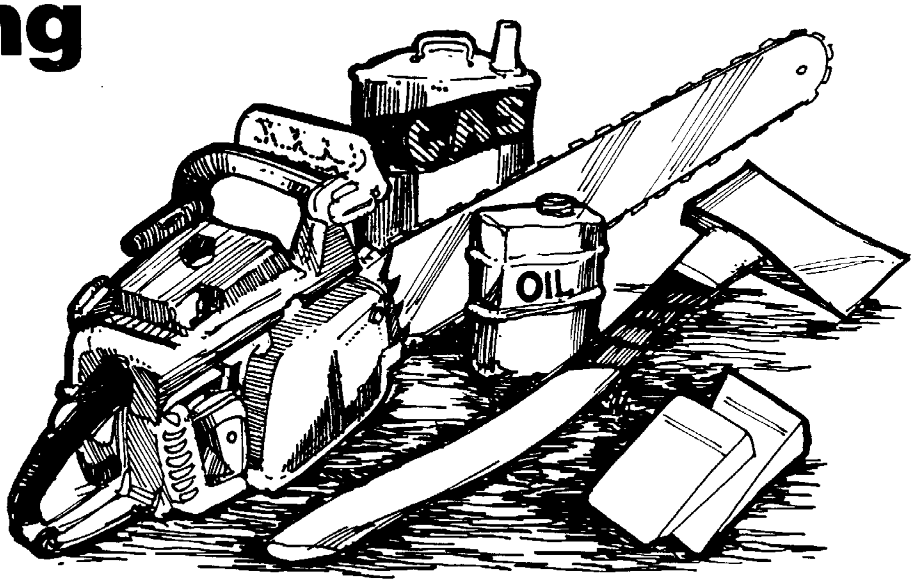
side. Draw a pencil line on the rollers where the outside of the left and right sides hit them. Cut out the cogs and fit them on rollers so they are touching the pencil lines on the right sides. Insert a ½” birch dowel between the cog and the end of the roller so it can be turned when winding on during weaving. Install the rollers into the loom and insert the dowel in the left side which keeps them from moving sideways. Position and install the rachets.

Construct the beater, being sure the reed can be easily removed. Set the beater on its pivot pins and check whether both sides of the beater strike the breast beam at the same time. If not, then check the distance of both the left and right sides of the breast beam to the box. Also double check the positioning of the pivot pins for the beater. They should be 6” and 8” back and 1” up. (When installing the pivots in the loom sides, use a 7/32” drill and work the drill around in the hole so it is bigger than 7/32”. The next drill size larger is too loose.) Insert the pin slowly by tapping it, taking care not to split the wood. This applies for using a 5” common nail cut off to 2¼” for a pin. (Different procedures would apply if dowel were used.) Height of the reed must also be doublechecked. Be sure the beater is centred between the sides, using wooden spacers on the pins if necessary.

Assemble the harness frames. Fit the guide pins for the harnesses into the box. The pins on each side must slide freely so the harness frames can be removed. Work the holes with the 15/64” drill until the pins slide properly. Tie ropes onto the eyehooks of tops of harness frames. These ropes go through their respective holes in the top of the box and are tied to pulls or are knotted so the harnesses are raised when the ropes are caught in their slots. If handles are used then set those up and adjust them, using patience and ingenuity. Handles are difficult to work out but they sure work well when properly done.

Round edges on breast and back beams and on the top of the beater. Sand the loom carefully and oil it with Danish or Teak oil, or a suitable substitute.

Log Falling & Bucking



Falling a tree requires a great deal more consideration than merely bringing it to the ground.

Considerations

1. Falling each tree in the safest possible manner.
2. Falling each tree with consideration being given to its subsequent safe bucking.

Before starting to fall timber, you should determine the best face or position to start the quarter or strip, generally with the timber stand's prevailing lean, if any, and in a manner which will allow the timber to fall into the clear. You should have knowledge of your falling position, in relation to roads in use, and to other equipment and workers in the area.

Finally you should have a thorough knowledge of the written procedures as explained on pages 120 to 125 inclusive.

1. Brush and debris adjacent to the tree to be felled shall be cleared away to permit the free and safe use of tools and to allow a quick, safe, unobstructed path to safety.

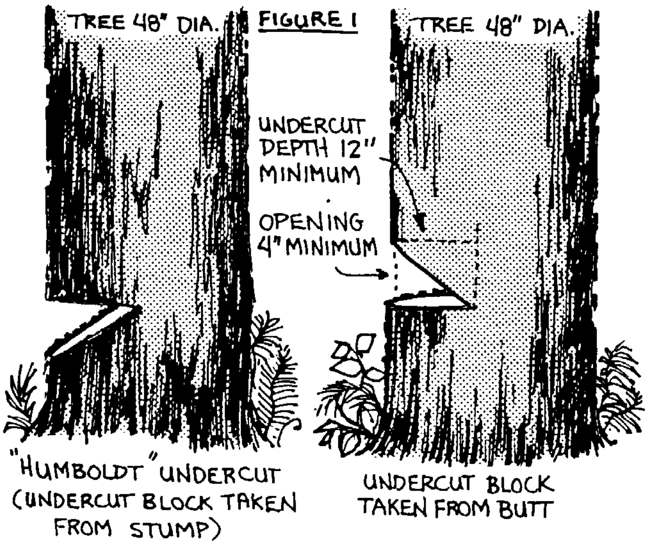

TREE 48" DIA.
TREE 48" DIA.
UNDERCUT DEPTH 12" MINIMUM
OPENING 4" MINIMUM
"HUMBOLDT" UNDERCUT (UNDERCUT BLOCK TAKEN FROM STUMP)
UNDERCUT BLOCK TAKEN FROM BUTT

FIGURE 1

2. Assess the tree or snag to determine the apparent situation with regard to:
   a) Loose limbs, chunks, or other overhead material.
   b) Logs, saplings, or chunks on the ground that could constitute a hazard.
   c) Other trees or snags being involved by contact when the tree being cut falls.
   d) The best escape route to a predetermined place of safety.
   e) Lean, if any.

Considerations at the Base of the Tree

A sufficient undercut shall be made in each tree being felled. You should ensure:

1. That the undercut is complete and cleaned out.
2. That appropriate measures are taken to control the fall of the tree.

The Undercut

Properly sawn, the undercut will allow the tree to fall freely in its chosen direction. A clean, uniform undercut should be used on all trees. The following guide is useful:

1. As a minimum, the undercut should be one-quarter of the tree's diameter.
2. As a minimum, the opening of the undercut should be one-third of the undercut's depth, or one inch vertical for every three inches horizontal.

Note:

1. Both undercuts shown in Fig. 1 are correct. However, some people like the "Humboldt" undercut for closer utilization.
2. The horizontal part of the undercut must be level and well cleaned out where the cuts meet to prevent "barber-chair" and/or unintended "Dutchman".
3. The undercuts shown are based on a one-inch opening

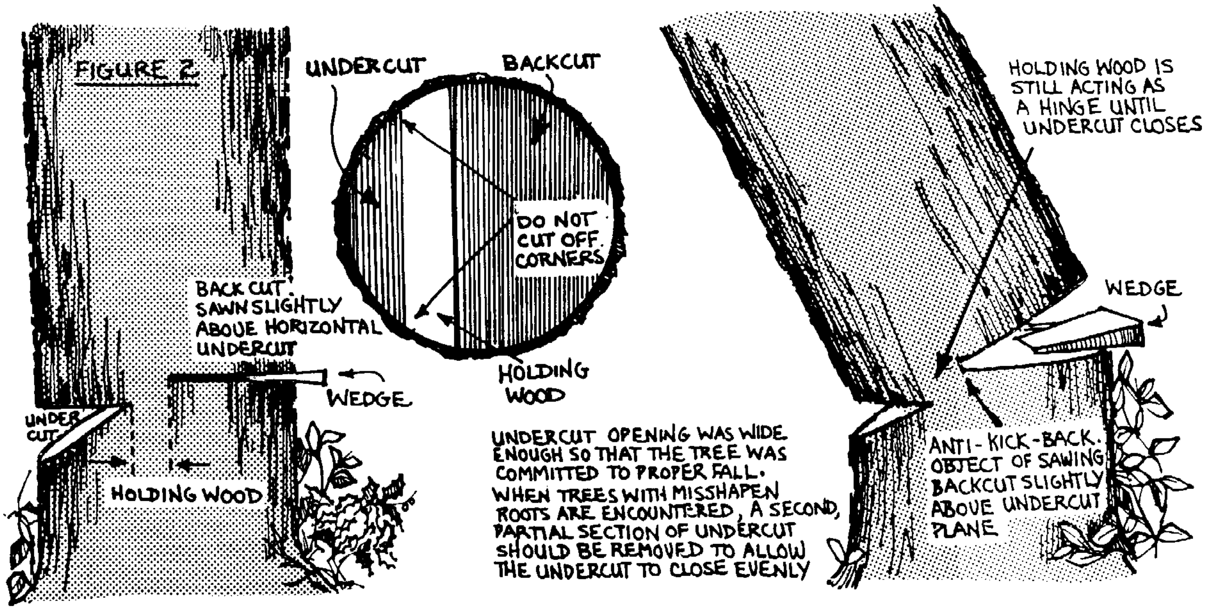


FIGURE 2
UNDERCUT
BACKCUT
DO NOT CUT OFF CORNERS
BACK CUT. SAWN SLIGHTLY ABOVE HORIZONTAL UNDERCUT
WEDGE
HOLDING WOOD
UNDER CUT
HOLDING WOOD
HOLDING WOOD IS STILL ACTING AS A HINGE UNTIL UNDERCUT CLOSES
WEDGE
ANTI-KICK-BACK. OBJECT OF SAWING BACKCUT SLIGHTLY ABOVE UNDERCUT PLANE

UNDERCUT OPENING WAS WIDE ENOUGH SO THAT THE TREE WAS COMMITTED TO PROPER FALL. WHEN TREES WITH MISSHAPEN ROOTS ARE ENCOUNTERED, A SECOND, PARTIAL SECTION OF UNDERCUT SHOULD BE REMOVED TO ALLOW THE UNDERCUT TO CLOSE EVENLY

for three inches of horizontal cut.

4. The two cuts which form the undercut must **not** cross at that point where they meet, in order to prevent formation of "Dutchman".

The Backcut

Sufficient holding wood must always remain to maintain control of the tree so that it does not break, slip, or twist off the stump, and fall in any direction other than that intended – no matter how heavy the lean.

1. The backcut must be level and sawn-in slightly above the horizontal plane of the undercut to form an anti-kick-back step.
2. Care must be taken not to saw the corners off when side notching (see Fig. 2).

Falling Against the Lean May be Necessary on Occasion to:

1. Avoid unnecessary breakage
2. Place the tree in a favourable bucking position
3. Avoid falling a tree into other adjacent standing trees
4. Keep a tree from falling on a road grade, or
5. Avoid crossing the lead or falling pattern.

To establish hard and fast guidelines for falling a tree against its lean would be most difficult because of the variations in lean, height, diameter, species, etc. In extreme cold weather, frozen wood becomes brittle and undependable as holding wood.

Make a habit of plumbing the tree before commencing falling, even if you feel sure you know where the lean is.

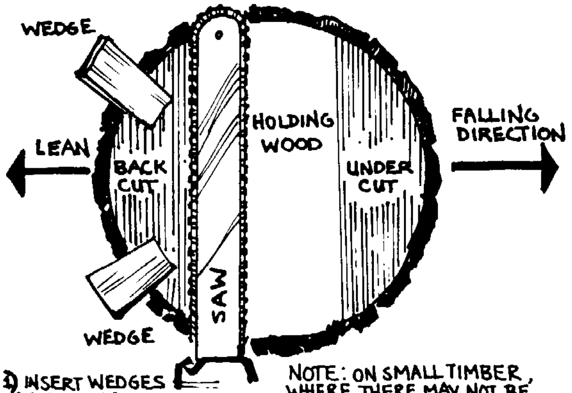
A large tree with heavy lean may be felled against its lean by inserting steel wedges in the **kerf** of the backcut, driving the wedges alternately as the backcut is sawn. (Always use eye protection when driving metal wedges, and keep your head above or below the wedge.)

Most trees can be felled away from their lean by using the normal falling wedges and by retaining additional holding wood as shown in Figs. 3 and 4.

"Dutchman" in the Undercut is caused by:

1. The undercut not being fully cleaned out, or
2. The two saw cuts of the undercut not meeting properly

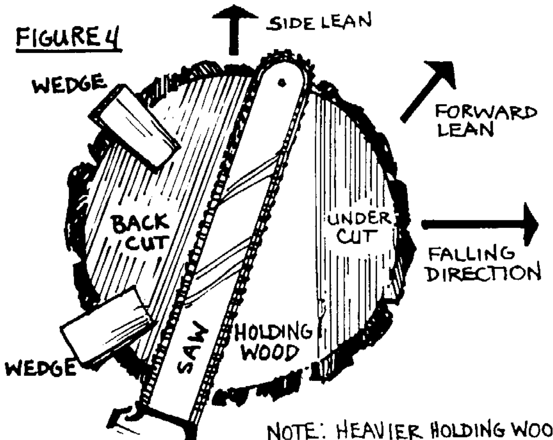
FIGURE 3.



1) INSERT WEDGES AS SOON AS POSSIBLE.
2) MAINTAIN AS MUCH HOLDING WOOD AS POSSIBLE.

NOTE: ON SMALL TIMBER, WHERE THERE MAY NOT BE ENOUGH ROOM FOR SAW-BAR AND WEDGES, THE BACK CUT SHOULD BE SAWN FIRST. REMOVE THE SAW AND DRIVE IN WEDGES BEFORE THE UNDER CUT IS SAWN OUT. FINISH FALLING WITH WEDGES.

FIGURE 4



1) CARE MUST BE TAKEN NOT TO CUT OFF THE HOLDING WOOD ON THE LEANING SIDE, AS THE TREE MAY SETTLE ON THE SAW BAR.

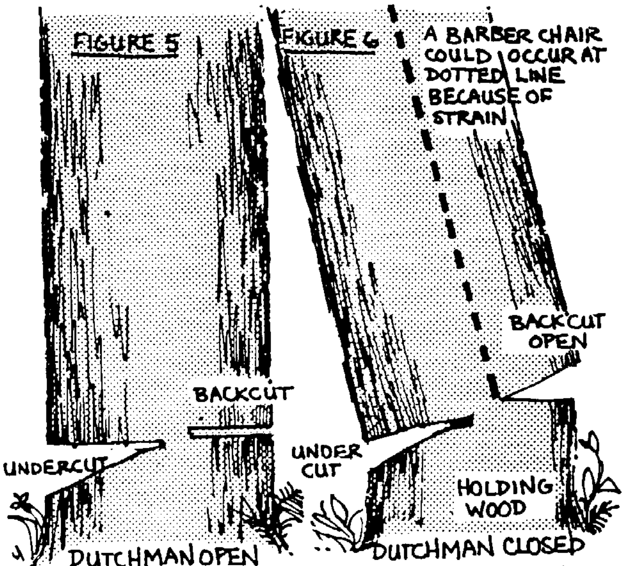
NOTE: HEAVIER HOLDING WOOD IS MAINTAINED OPPOSITE TO ANY SIDE LEAN. THIS WILL HELP DRAW THE TREE AWAY FROM ANY SIDE LEAN.

by allowing the top or bottom cut of the undercut to be sawn past the other.

The result is that, as the tree starts to fall, the Dutchman closes, usually throwing the tree away from its intended direction of fall. This action may allow the tree to fall among other adjacent standing trees or snags, creating a hazardous situation for you from broken limbs or tops being thrown back towards you.

Intentional "Dutchman" has been used by fallers to help them overcome a particular falling problem when the need to pull or throw a tree could not be achieved by other means; and then, only after understanding and evaluating the hazards involved.

Even for the most seasoned and skillful faller, the amount of pull or throw created by the Dutchman cannot always be determined – thus a lack of control could ensue. For this reason the use of Dutchman, even intentional, is not advocated (see Fig. 5).



THE UNDERCUT AND BACKCUT HAVE BEEN SAWN. THE TREE IS READY TO FALL.

Poor Falling Practices

1. The practice of hanging one tree in another, deliberately, for the purpose of holding pressure to eliminate wedging while working on the forward tree is excessively hazardous and therefore prohibited.
2. Excessive pushing or "domino" falling. The practice of pushing one tree with another must only be done to overcome a falling difficulty, or where there is no better method.
3. Working within range of a tree which has been "cut-up" (except work processes required in order to get the tree down).
4. Standing under the lean or loose material while making the falling cuts.
5. Failing to move quickly away from the falling tree on a predetermined and prepared escape route.
6. Falling without having wedging equipment immediately available, or neglecting to place a wedge in the backcut as soon as possible.
7. Falling timber during periods of high wind, dense fog, heavy snowfall, or when heavy snow is on the limbs.
8. Falling trees too close to adjacent fallers, other workers or equipment.

Bucking

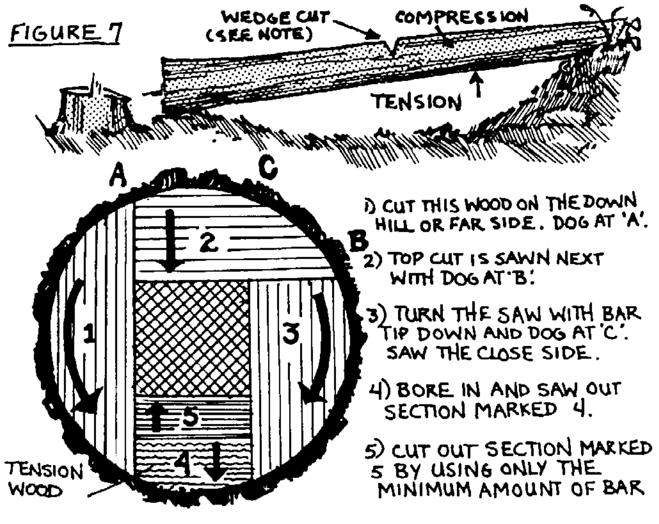
Before starting any bucking cut, buckers should plan the work by analyzing log movements and other hazards that may develop as a cut log is released, such as pivot points, natural skids, soundness of log being bucked, etc. You should:

1. Make sure of firm footing. Avoid standing on loose chunks or logs with bark or material that will roll when a log is sawn off. (Peel away loose bark underfoot.)
2. Stand to one side of the power saw while cutting. Avoid standing directly behind saw to prevent a blow to the body from a kick-back. Be able to handle a saw either right or left-handed.
3. When a falling tree brushes a snag, or other weak or unstable tree, leave the tree unbucked until the snag or defective tree is felled.
4. Always be on the look-out for limbs or other objects hanging above in standing timber.
5. When bucking blown-down trees, or where windfalls are present, fall the snags to prevent them being struck by rolling logs released during bucking.
6. Buck the bottom windfalls of a "jackpot" first, to avoid top logs or material from rolling.
7. Avoid bucking any windfalls on hillsides above the immediate falling area or face.
8. When working in a windfall area, be mindful of loose bark which could result in a serious fall.

Top Bind

When a tree is lying in a position in which the top side is compressed while the bottom is under tension, the tree can be safely bucked without any wood splitting, or the saw bar being pinched, by making cuts in the following sequence:

FIGURE 7



1) CUT THIS WOOD ON THE DOWN HILL OR FAR SIDE. DOG AT 'A'.
2) TOP CUT IS SAWN NEXT WITH DOG AT 'B'.
3) TURN THE SAW WITH BAR TIP DOWN AND DOG AT 'C'. SAW THE CLOSE SIDE.
4) BORE IN AND SAW OUT SECTION MARKED 4.
5) CUT OUT SECTION MARKED 5 BY USING ONLY THE MINIMUM AMOUNT OF BAR.

NOTE: A WEDGE SECTION SHOULD BE REMOVED WHEN SAWING CUT 2 IF THE TOP BIND IS EXCESSIVE, TO ALLOW THE TREE CUT TO CLOSE AS CUTS 4 AND 5 ARE MADE. ARROWS INDICATE SAW TRAVEL DIRECTION AND CROSSHATCHING INDICATES THE HEARTWOOD WHICH WILL BREAK. DEPENDING UPON SOUNDNESS OF WOOD AND TIMBER LIE, IT MAY BE ADVANTAGEOUS TO USE THE END OF THE BAR AND BORE FROM POINT "C" IN. MAKING CUTS NUMBER 1 AND NUMBER 3 IF IT APPEARS THERE MAY BE DANGER OF THE LOG SLABBING.

Bottom Bind

Cuts are made in almost the same manner as for top bind, except for the top and bottom cuts which are reversed.

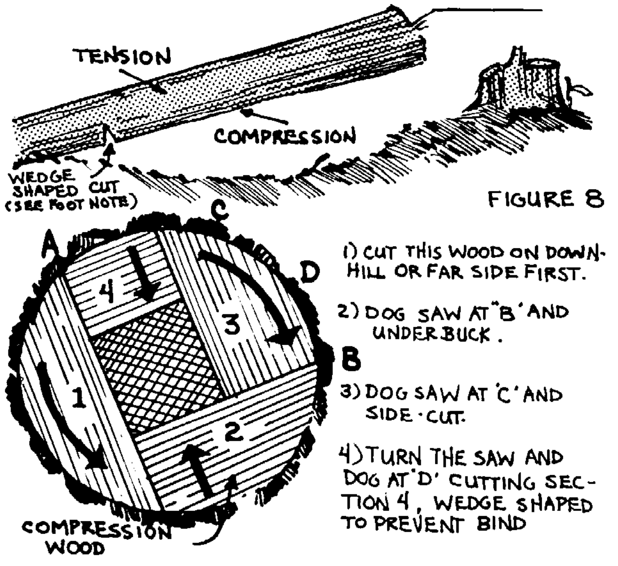


FIGURE 8

1) CUT THIS WOOD ON DOWN-HILL OR FAR SIDE FIRST.

2) DOG SAW AT "B" AND UNDERBUCK.

3) DOG SAW AT 'C' AND SIDE-CUT.

4) TURN THE SAW AND DOG AT 'D' CUTTING SECTION 4, WEDGE SHAPED TO PREVENT BIND

NOTE: ARROWS INDICATE SAW TRAVEL DIRECTION AND CROSS-HATCHING INDICATES HEARTWOOD WHICH WILL BREAK. AS IN TOP BIND, A WEDGESHAPED SECTION COULD BE TAKEN OUT WHEN SAWING CUT 2 TO ALLOW FORCLOSING ON SEVERE BIND.

Bucking Large Logs

In the cutting of big logs, buckers have a tendency to buck off as much of the far side of the log as they can by reaching over the side from the top of the log (see "B", No. 2 Position). This practice quite often results in a section of the lower left side of the cut remaining unbucked.

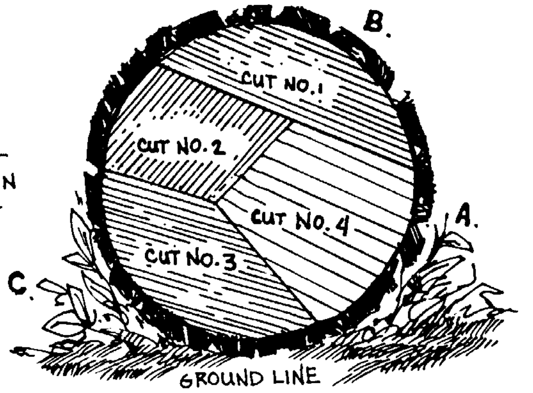
The diagram below indicates a safe method of bucking a large log.

1. Saw into the top of the log about 12-14 inches from Position "A".
2. From Position "B" cut off the lower side of the log right into the heart wood.
3. From Position "C" cut off all remaining wood on the low side of the cut.
4. Return to safe Position "A". Cut off balance of wood to complete the cut.

Note: You should carefully size up log lie and condition of log before adopting the third bucking position to ensure that no untoward event could take place which could endanger you.

FIGURE 9

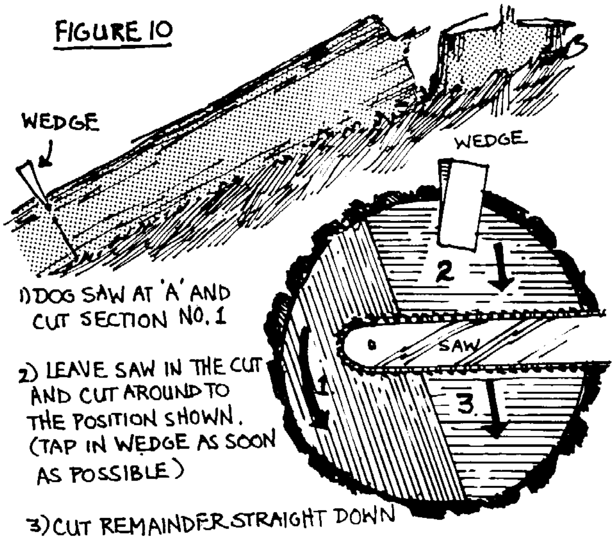
A. FIRST AND LAST BUCKING POSITION
B. SECOND BUCKING POSITION
C. THIRD BUCKING POSITION



End Pressure

When a tree is lying flat on steep terrain, straight up and down the slope, a bucked log would have a tendency to slide down, causing the bar to be pinched as the log was bucked off. Matching top and bottom cuts can be made without end pressure on the bar by inserting a wedge as shown in Fig. 10.

FIGURE 10



1) DOG SAW AT 'A' AND CUT SECTION NO. 1

2) LEAVE SAW IN THE CUT AND CUT AROUND TO THE POSITION SHOWN. (TAP IN WEDGE AS SOON AS POSSIBLE)

3) CUT REMAINDER STRAIGHT DOWN

NOTE: THE ENTIRE CUT CAN BE MADE WITHOUT REMOVING THE SAW. THE WEDGE CAN BE TAPPED OUT AFTER CUTTING IS COMPLETED.

Pivot Points

As an example of unexpected action, a faller was killed when the windfallen tree he was bucking swung uphill, crushing him under the butt. The windfallen fir tree, 30 inches in diameter by 90 feet in length, was lying across a steep sidehill. The butt end was rooted while the small end was resting on chunks. The first cut was made 12 feet from the root. The faller, expecting both the tree and root to roll away from him, finished the cut from the uphill side. As the cut was released, the butt end of the tree swung uphill because of a small stump located under the windfallen tree.

Bind

Bind can be expected in most trees that are felled because of uneven terrain and other material already on the ground. The bind can also be present in combinations of top bind and side bind, or bottom bind and side bind.

The best defence you can have in order to avoid personal injury or equipment damage caused by bind and/or poorly chosen cut is to examine the felled tree carefully and determine any bind which may be present, and what action will take place when, or as, the bucked log is released.

Many serious and fatal accidents have occurred because fallers or buckers failed to recognize side bind during bucking activities. They had positioned themselves on the side to which the bucked log "sprung" or swung upon release.

Falling and Bucking Difficulties

Tree Sits Back

Just as you are completing the backcut, the tree starts to sit back on the bar. This can happen because:

1. You misjudged the tree's lean.
2. The stump contained hidden rot.
3. An unexpected gust of wind took it backwards.
4. You neglected to place a wedge in the backcut as it was being sawn.

If sufficient holding wood remains, the tree may be wedged-over in its intended direction. Be sure to clean the bark away, above and below the back-cut, to allow wedges to bear on solid wood.

The tree may be leaning backwards heavily, and wedges cannot be started in the back-cut. You are left with several choices:

1. You may fall the tree over backwards.
2. You may use a hydraulic jack.
3. You may "push" this tree over by falling another tree into it.

The Second Undercut

Fig. 11 depicts a large tree which has "sat back" heavily on the backcut. The faller has sawn a good-sized second undercut at an angle on the right or left side (depending on best lay and escape). The second undercut has been sawn from the stump, but the topcut of the new undercut is the original backcut. By sawing the second undercut at an angle, part of the backcut will remain intact to support the tree while the second undercut is sawn in. When the second undercut is well cleaned out, the faller should run the saw into the original undercut and saw off the holding wood.

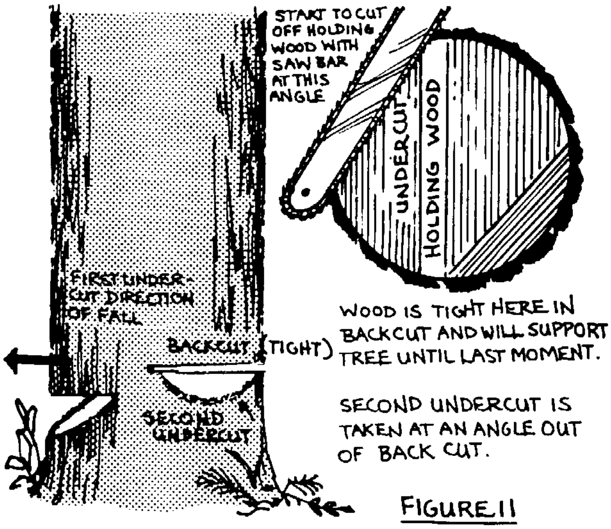

START TO CUT OFF HOLDING WOOD WITH SAW BAR AT THIS ANGLE
UNDERCUT
HOLDING WOOD
FIRST UNDER-CUT DIRECTION OF FALL
BACKCUT (TIGHT)
WOOD IS TIGHT HERE IN BACKCUT AND WILL SUPPORT TREE UNTIL LAST MOMENT.
SECOND UNDERCUT
SECOND UNDERCUT IS TAKEN AT AN ANGLE OUT OF BACK CUT.

FIGURE 11

As the tree falls, very little control can be maintained because of the large "Dutchman" which developed, and because all the remaining holding wood has been sawn off.

Fig. 12 depicts the same situation, except that a bit more control can be maintained by sawing the holding wood over its entire width. The small undercut would act as a lip to help prevent the butt from sliding backwards. The choice of these two methods would depend largely on the direction in which the tree appears to be leaning, obstructions to its free fall, steepness of terrain, and the location of the new escape path.

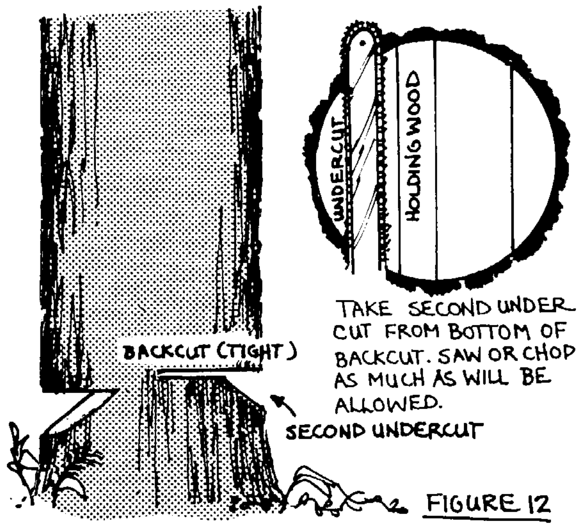

UNDERCUT
HOLDING WOOD
BACKCUT (TIGHT)
TAKE SECOND UNDER CUT FROM BOTTOM OF BACKCUT. SAW OR CHOP AS MUCH AS WILL BE ALLOWED.
SECOND UNDERCUT

FIGURE 12

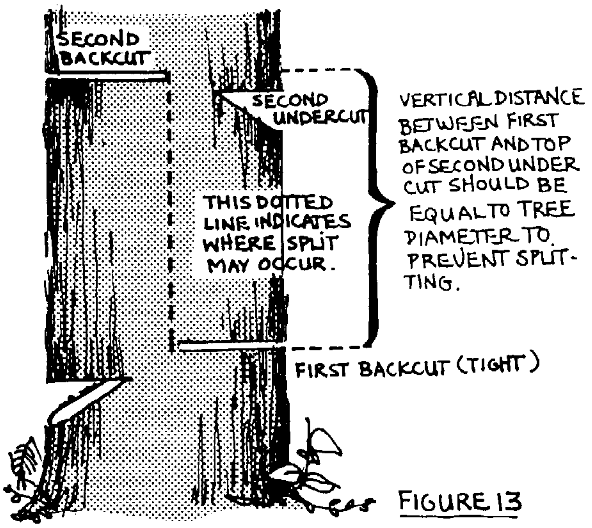

SECOND BACKCUT
SECOND UNDERCUT
THIS DOTTED LINE INDICATES WHERE SPLIT MAY OCCUR.
VERTICAL DISTANCE BETWEEN FIRST BACKCUT AND TOP OF SECOND UNDER CUT SHOULD BE EQUAL TO TREE DIAMETER TO PREVENT SPLITTING.
FIRST BACKCUT (TIGHT)

FIGURE 13

Figure 13 will allow for most control being maintained as a proper undercut, backcut and holding wood can be sawn in above the original cuts. Maintain as much vertical distance between the first falling cuts and the new falling cuts – at least the measurement of the tree's diameter. A danger exists that a vertical split may occur between the first and second set of cuts.

Pushing One Tree by Falling Another Into It

Because of the hazards involved, this practice should only be done to overcome a falling difficulty when:

1. The tree may be limb-tied to another.
2. The tree may be leaning against another.
3. The tree has settled backwards and you are unable to start wedges.

Hazards

1. You may only brush the tree being pushed, which may sway and fall over into the area where you are standing.
2. A dry top or limbs may be broken off and thrown back towards you.

If pushing becomes necessary, ensure that:

1. The pushing tree is at a good angle – no more than 20 degrees off the imaginary centre line behind the tree being pushed.
2. Extra protection with regard to the undercuts and holding wood of both trees is taken.
3. An unobstructed get-away path is located and the surroundings well sized-up.

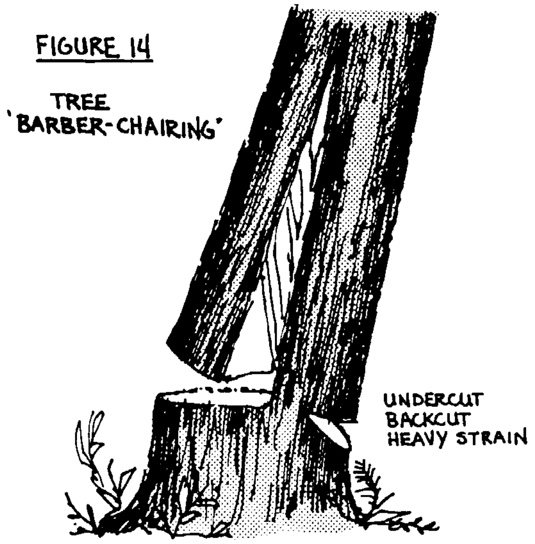
When difficulties arise with an incompletely felled tree, you should direct all your efforts to getting the tree down safely. Under no circumstances should you continue with unrelated work in the area of the "cut-up" tree.

Heavy Leaners

A tree with a heavy lean develops enormous tension in the wood directly behind the lean. When an undercut is put into the tree, in the direction of the lean, then the tension is further aggravated. As soon as a conventional backcut is started, this tension is immediately relieved and the tree starts to fall. However, too much holding wood remains, and instead of the holding wood breaking off normally, the tree trunk will split vertically from where the backcut is started. A huge slab will develop and kick backward at the same time, causing the "barber-chair".

To prevent barber-chairing it is necessary to leave that part of the wood which is most under tension, located behind the lean, until more of the holding wood is sawn out. Several methods may be employed in removing the excessive holding wood.

FIGURE 14



Side Notching

After the undercut block has been removed cleanly, the sides of the tree are side cut or side bored as shown in Fig. 15.

The remaining holding wood of the backcut will be sawn faster, with less likelihood of the tree splitting.

FIGURE 15

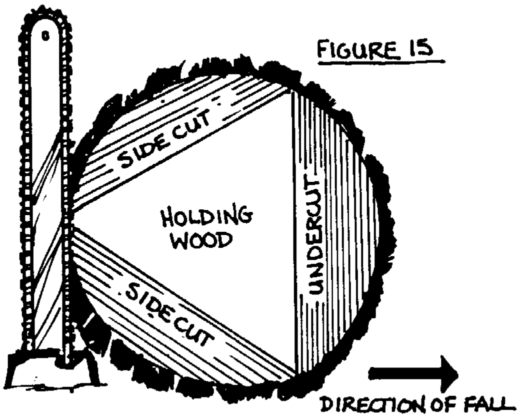


FIGURE 16

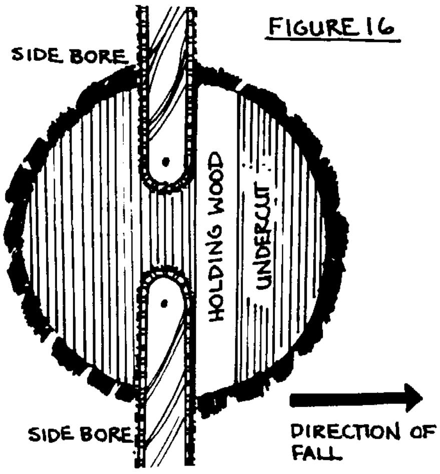
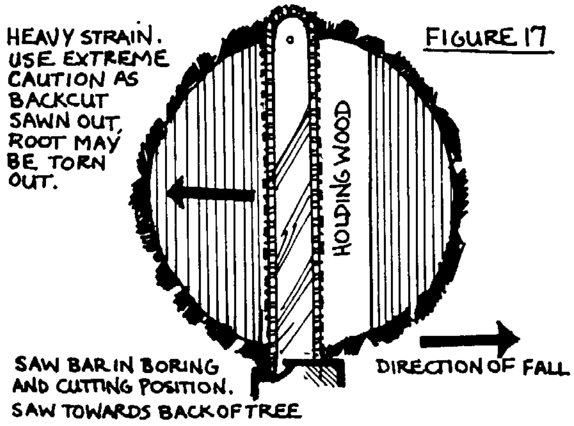


FIGURE 17


HEAVY STRAIN. USE EXTREME CAUTION AS BACKCUT SAWN OUT, ROOT MAY BE TORN OUT.
HOLDING WOOD
SAW BAR IN BORING AND CUTTING POSITION. SAW TOWARDS BACK OF TREE
DIRECTION OF FALL

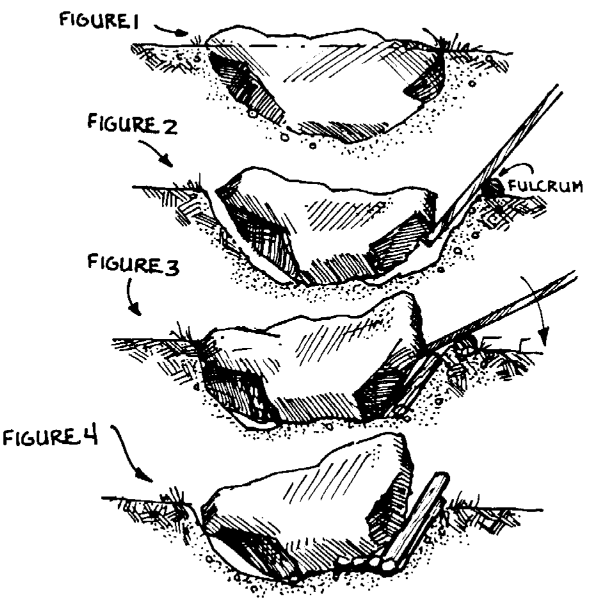
Boring the Backcut

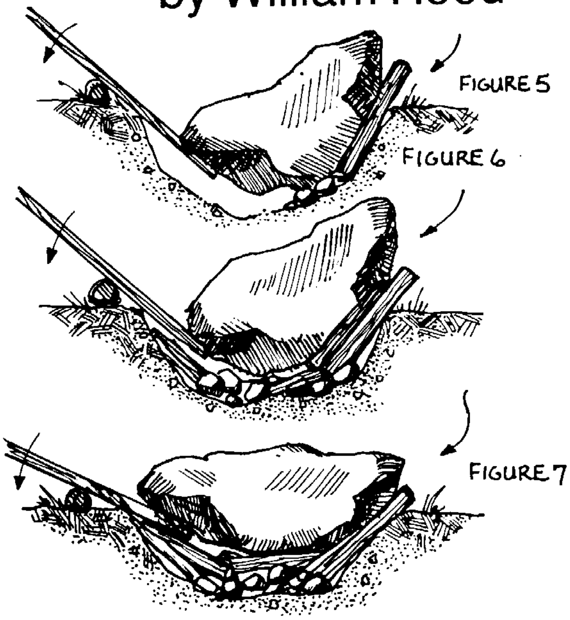
After the undercut block has been removed, the tip of the saw bar is bored into the tree on the same plane as the horizontal of the undercut. You must ensure that you leave a few inches of holding wood between the start of the boring cut and the back of the undercut. It may be necessary to bore in from both sides if the tree is wider than the length of the bar, (see Fig. 16). The saw is worked backwards, cutting from the inside out, until the point is reached where the normal backcut would have been started (see Fig. 17).

At this time, the wood directly behind the lean will be under enormous tension as all other holding wood has been severed. Trees have been known to fall at this time, before the saw has cut through, pulling a large section of root out of the ground.

Raising Large Stones

by William Hood





The area which we chose for a site for our garden was underlain with a number of glacially deposited boulders weighing up to 500 pounds. We could have, as did the previous owners of the property, ploughed around these encumbrances but, being perfectionists, we could not tolerate unwanted materials of such density lying below the surface of our soil. Consequently, as the neighbour's plough bounced off each boulder, we set a marker at the spot and later with probes outlined the area of the stone and calculated our chances of raising and removing same. Of the fifteen or so we encountered, none appeared too large to handle, so we commenced digging with long handled shovels around the boulders and, where possible, to their full depth. When the boulders were suitably exposed, we started levering them from the underlying matrix with an old car axle, using pieces of suitable square timber for fulcrums. When a boulder proved unyielding, we found that a few buckets of water poured into the hole and allowed to settle also helped to free the boulder from its bed.

Two persons are necessary to efficiently raise the stones. One or both can use the pry to lever the stone upwards to a point where a new bite and a larger fulcrum becomes necessary. As one person with the pry holds the stone at its new position, the other person packs suitable material under the stone to prevent it slipping back into the hole. Pieces of firewood or short pieces of scrap lumber will hold most stones until a new bite is obtained on the opposite side of the stone. The process is repeated from side to side until the stone is at ground level, at which time it is wise to bridge the hole with plank or poles so that the stone can be manipulated away from the hole.

We were fortunate to have the hood from a vintage Pontiac which we use most effectively as a stoneboat. It is quite simple for us to push the open end of the hood up tight to the stone and to roll or pry it onto our stoneboat. Our 14 horsepower garden tractor easily draws this apparatus with the stone on board away from the garden site, and it becomes a simple matter to roll the stones off the hood when the stone-pile is reached.

Of course if the stones to be raised and moved are anything but large granite cobbles, as in our case, which defy conventional breaking, one can usually break them, particularly in winter, if they are well heated under a scrap wood fire and doused with buckets of cold water while hot. This method will usually break the stones along their lines of cleavage into manageable pieces.

Another method for breaking large boulders is by the use of dynamite in a method called mud capping. However I would not advocate the use of blasting materials unless a person is thoroughly familiar with blasting techniques and safe handling of powder, detonators and fuse. The method is simple when done by an experienced blaster and is accomplished by placing a charge on top of the stone and forcing the explosive force downwards, thereby shattering the stone. The dynamite is removed from its waxed paper cylinder and according to the size of the stone to be broken, is placed on top of the stone in a quantity from one half to a suitable number of whole sticks. The dynamite is arranged as compactly as possible on the stone at a place where the stone would be struck with a hammer if it were possible to break it that way. A detonator with a suitable length of fuse is embedded in the dynamite and this, known as the charge, is then covered with mud to a convenient thickness, but not less than five inches. The end of the protruding fuse (not less than three feet long) is split to facilitate lighting and ignited with a match or spill. The resulting blast will usually fracture the stone.

Glossary

apron Piece of canvas attached to the warp and cloth beams to which the warp ends are tied.

back beam Bar at back of loom over which warp passes from warp beam.

backcut Final falling cut. The backcut will progress until the tree starts to fall in its intended direction.

backsaw Handsaw with a thin blade having 11 to 16 teeth/inch. It is primarily used for finishing work in which precise cutting of straight lines is important.

bar or blade The part of the chain saw on which the cutting chain travels.

barber-chair The configuration of a tree stump (shaped as a chair) resulting from a tree splitting as it is felled; usually the result of poor falling cuts.

beam A wooden cylinder forming that portion of a weaver's loom on which the warp is wound before weaving; also, the cylinder on which the cloth is wound during the process of weaving.

bearings Any part of a machine in or on which another part revolves, slides, etc.

beater Frame holding reed. Used to "beat" weft thread back into place in the web.

bevel The sloping edge of a board which forms an angle greater or less than 90° with the surface.

bind or bound Compression created in a tree or a log due to uneven terrain or contact pressure from other trees or logs.

bit A sharp-edged tool for drilling or boring, having a shank for attachment to a brace, drill press, etc.

blow-down An area of standing timber which has been blown over by strong winds or storms.

board foot A unit of measurement by which board lumber is priced, represented by a piece 1" by 1' by 1' or its cubic equivalent.

bobbin(s) A spool or reel holding thread (or yarn) for spinning, weaving or machine sewing.

boring Cutting with the nose of the power-saw bar to cut from inside the log or tree.

breast beam Bar at front of loom over which fabric passes before it winds on the cloth beam.

buck or bucking To saw lengths from a tree after it has been felled.

burrs(metal) A roughness or rough edge, especially one left on metal in cutting or casting.

bushing Metal lining of circular orifice.

butt That end of the log or tree sawn from the stump, i.e., butt-end.

calipers An instrument resembling a pair of compasses, usually with curved legs, used for measuring diameters.

channel A shape which is like a dado or groove.

chimney flue A passage housed in a chimney through which smoke and gases are carried from a fuel burning appliance, fireplace or incinerator to the exterior.

cloth beam The front roller on which the cloth is wound as it is being woven. The roller holds the web at the correct tension.

countersink To drill a conical depression at the mouth of a screw hole to set a flathead screw flush with or below the surface. Also, the tool employed to accomplish this purpose.

cove Inward sloping arch.

cull A tree or log which is considered unusable because of defects.

dead centre A non-rotating centre, as on a lathe. See **spindle.**

dent Single space in a reed.

distaff A staff on which flax, wool, etc., is wound for use in spinning.

dogs Pointed teeth located between the chain saw blade and motor for use when falling or bucking to pivot saw and maintain position while sawing.

dowel A wooden stick 1/8" to 1½" in diameter used for making furniture joints, plugging screw holes and other purposes.

draft Drawing on ruled paper indicating the placement of the threads in the harnesses used in threading loom.

dutchman Portion of the undercut not removed. Can change falling direction of the tree. Very hazardous if improperly used.

edge grain Lumber that is sawn along the radius of the annual rings or at an angle less than 40° to the radius is edge-grained; this term is synonymous with quarter-sawn.

emery A very hard black or greyish-black variety of corundum, used as an abrasive.

end grain The face of a piece of lumber which is exposed when the fibres are cut transversely.

eye A loop of wire, metal or thread used for securing a warp thread in a heddle.

face Edge of area formed along standing timber as timber is felled.

faceplate A disc that holds and rotates work, as on a lathe or boring mill.

fascia Long wood board under eaves.

feathering Reducing gradually to a very thin edge.

ferrule A bushing; a metallic lining for a hole as in the hub of a wheel, designed to insulate or to prevent abrasion between parts.

fire clay A clay of high heat-resisting qualities used to make fire brick and the mortar in which fire brick is laid.

flange A projecting edge, rib, or rim; the top and bottom of I-beams and channels are called flanges.

flashing Sheet metal or other material used in roof and wall construction to shed water.

footing The widened section, usually concrete, at the base or bottom of a foundation wall, pier, or column.

gable The upper triangular-shaped portion of the end wall of a house.

gable end The entire end wall of a house having a gable roof.

gauge A standard for measuring e.g. diameter of nails or wire and thickness of metal sheets.

gouge A chisel having a scoop-shaped blade used chiefly for carving or cutting wood.

harness Frames on which heddles are hung.

heddles Wire, twine, or flat pieces of steel with holes or eyes in center through which warp ends are threaded.

hip The sloping edge of a roof formed by two intersecting roof slopes.

hip-rafter The rafter which forms the hip of a roof.

holding wood Hinge of wood left uncut between the back of undercut and the backcut.

jack-pot A pile of haphazardly felled trees.

jack type looms A rising type loom in which only the harnesses which are to rise are attached to any heddle.

kerf The width of any saw cut.

kick-back When the power saw is jerked out of the faller's control, common cause of saw cuts on the arms and legs. Also, when a tree being felled slips backwards off the stump toward the faller.

lam Horizontal bar between heddle frame and treadle used to keep the heddle frames balanced.

lap joint Uniting two pieces of wood by overlapping their surfaces, usually by cutting away half the thickness of each piece so their surfaces are flush.

lay The position in which a felled tree is lying.

lead The established direction in which all trees in a quarter or strip are to be felled, usually governed by general slope or terrain.

lean Outward slant of a tree with reference to its base.

leaner A tree which leans, not growing perpendicularly.

lintel A horizontal structural member (beam) that supports the load over an opening such as a door or window.

live centre The centre of a rotating spindle, turning with the work, as on a lathe. See also **spindle.**

masonite Masonite are hardboard panels produced from by-product wood chips reduced to the cellulose fibres by high steam pressure.

mitre box A device used as a guide in sawing wood at an angle for mitre joints.

mortise A space hollowed out in a piece of timber, stone, etc., and shaped to fit a tenon to which it is to be joined.

mortise and tenon joint A furniture joint accomplished by fitting a tenon on one member into a mortise on another.

offside Opposite side to which the faller stands when falling or bucking.

peen To shape with the round end of a ball-peen hammer.

pitch Distance between successive points or lines, e.g., between successive teeth of cog wheel or threads of a screw.

pitman A rod that connects a rotary with a reciprocating part; a connecting rod.

plate A beam or piece of timber laid horizontally in a wall to receive the ends of other timbers.

rabbet An L-shaped cut in the edge of a board.

ratchet Wheel at end of warp and cloth beams to facilitate winding.

reed Comblike part of the beater, made of metal.

rest A device for supporting the turning tool or the work in a lathe.

ridge board A horizontal member usually ¾" thick at the upper end of the rafters, to which these rafters are nailed.

scantling Small beam under five inches in breadth and depth.

school-marm A tree stem which branches into two or more trunks or tops.

set-back Occurs when a tree settles back opposite to the intended direction of fall; hazardous situation when faller loses control of a tree.

shed Opening formed in warp, by raising or depressing harnesses, through which the shuttle is passed.

shed roof A sloping roof having its surface in one plane.

shims A piece of metal or other material used to fill out space, as where joints are worn loose, or between something and its support.

shoulder In carpentry the square end of an object at the point where the tenon commences, as of a spoke, the stile of a door, etc.

shuttle A device used in weaving to carry the weft to and from between the warp threads.

side-notch Additional side saw cuts made to prevent "barber-chair" or to facilitate sawing large trees to logs.

sidewinder A tree which does not fall in the required direction while being felled.

sill The horizontal member forming the bottom of an opening such as a door or a window.

sleeve To be enclosing rod of smaller tube.

snag Any dead or dying tree, ten feet or more in height.

spiked top The top of a tree may die and lose its branches, leaving a tall, dry spike of dead wood (usually occurs in cedar).

spindle In a lathe, a shaft-like part (live spindle) that rotates while holding the thing to be turned, or a similar part (dead spindle) that does not rotate.

tabby Usually used to describe plain weave. Can also apply to thread inserted between pattern threads.

tailstock That standard or stock of a lathe through which passes the nonrotating spindle or dead centre.

tenon A projecting part cut on the end of a piece of wood for insertion into a corresponding hole (mortise) in another piece to make a joint.

tie-up Tying of lams to treadles.

treadle A lever operated by the foot, usually to cause rotary motion.

trunnion Supporting cylindrical projection on each side of an object such as a cannon, moveable saw, etc.

turn To shape (an object) in rounded form by turning on a lathe or other cutting tool.

vise A clamping device, usually of two jaws made to be closed together with a screw, lever, etc., used for grasping and holding objects being worked on, glued, etc.

warp The threads running lengthwise in the loom and crossed by the weft or woof. Also, to arrange threads or yarns so as to form a warp.

warp beam The roller or beam in a loom on which the warp is wound.

whip beam Beam at back of loom directly above warp beam; corresponds in position to breast beam at front of loom; also called "slab" or back beam.

widow maker Limb or other loose material dropped or thrown from a tree toward the faller as the tree is felled; a constant hazard for fallers.

wind falls Trees blown over by the wind, etc., lying among standing timber.

Metric Conversion Table

METRIC SYSTEM

Length

Meter = 1.093 yards
= 3.281 feet
= 39.370 inches
Kilometer = 0.621 mile

Surface

Square meter = 1.196 square yards
= 10.764 square feet
Square centimeter = 0.155 square inch
Square Kilometer = 0.386 square mile
Hectare = 2.471 acres

Volume

Cubic meter = 1.308 cubic yards
= 35.314 cubic feet
Cubic centimeter = 0.061 cubic inch
Stere = 0.275 cord (wood)

Capacity

Liter = 0.880 Imperial liquid quart or
= 1.056 U.S. liquid quarts
= 0.908 dry quart
= 0.220 Imperial gallon or
= 0.264 U.S. gallon
Hectoliter = 2.75 English bushels or
= 2.837 U.S. bushels

Weight

Gram = 15.432 grains
= 0.032 troy ounce
= 0.0352 avoirdupois ounce
Kilogram = 2.2046 pounds avoirdupois
Metric ton = 2204.62 pounds avoirdupois
Carat = 3.08 grains avoirdupois

ENGLISH

Length

Yard = 0.9144 meter
Foot = 0.3048 meter
Inch = 0.0254 meter
Mile = 1.609 kilometers

Surface

Square yard = 0.836 square meter
Square foot = 0.092 square meter
Square inch = 6.45 square centimeters
Sqare mile = 2.590 square kilometers
Acre = 0.405 hectare

Volume

Cubic yard = 0.764 cubic meter
Cubic foot = 0.028 cubic meter
Cubic inch = 16.387 cubic centimeters
Cord = 3.624 steres

Capacity

Imperial liquid quart = 0.7883 liter
U.S. liquid quart = 0.946 liter
Dry quart = 1.111 liters
Imperial gallon = 4.543 liters
U.S. gallon = 3.785 liters
English bushel = 0.363 hectoliter
U.S. bushel = 0.352 hectoliter

Weight

Grain = 0.0648 gram
Troy ounce = 31.103 grams
Avoirdupois ounce = 28.35 grams
Pound = 0.4536 kilogram
Short ton = 0.907 metric ton